Secretariat of the Pacific Regional Environment Programme

# APEC Climate Symposium

## Dynamical, Statistical and traditional climate forecasting in the Pacific Island countries: What we do now and challenges for future

**Philip Malsale    Port Moresby   21/08/18**

# Outline

- SPREP background
- Statistical models
- Dynamical models
- Traditional Knowledge
- Challenges and way forward

# What is SPREP

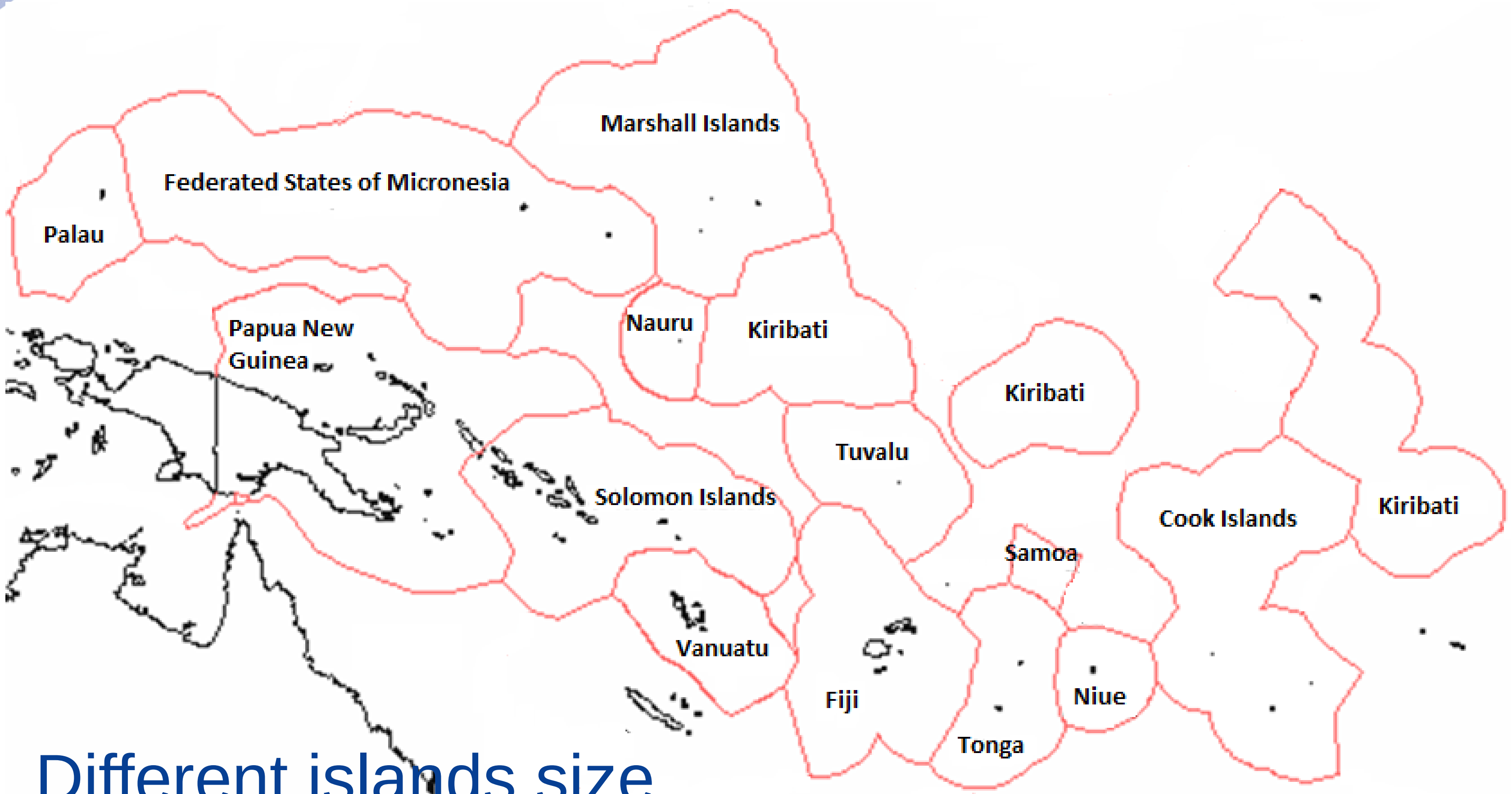
- Secretariat of the Pacific Regional Environmental programme (SPREP)

The Strategic Plan 2017–2026 prioritises four regional goals with supporting objectives. Together these define the core priorities and focus of SPREP for the next ten years:

- Climate Change Resilience
- Ecosystem and Biodiversity Protection
- Waste Management and Pollution Control
- Environmental Governance

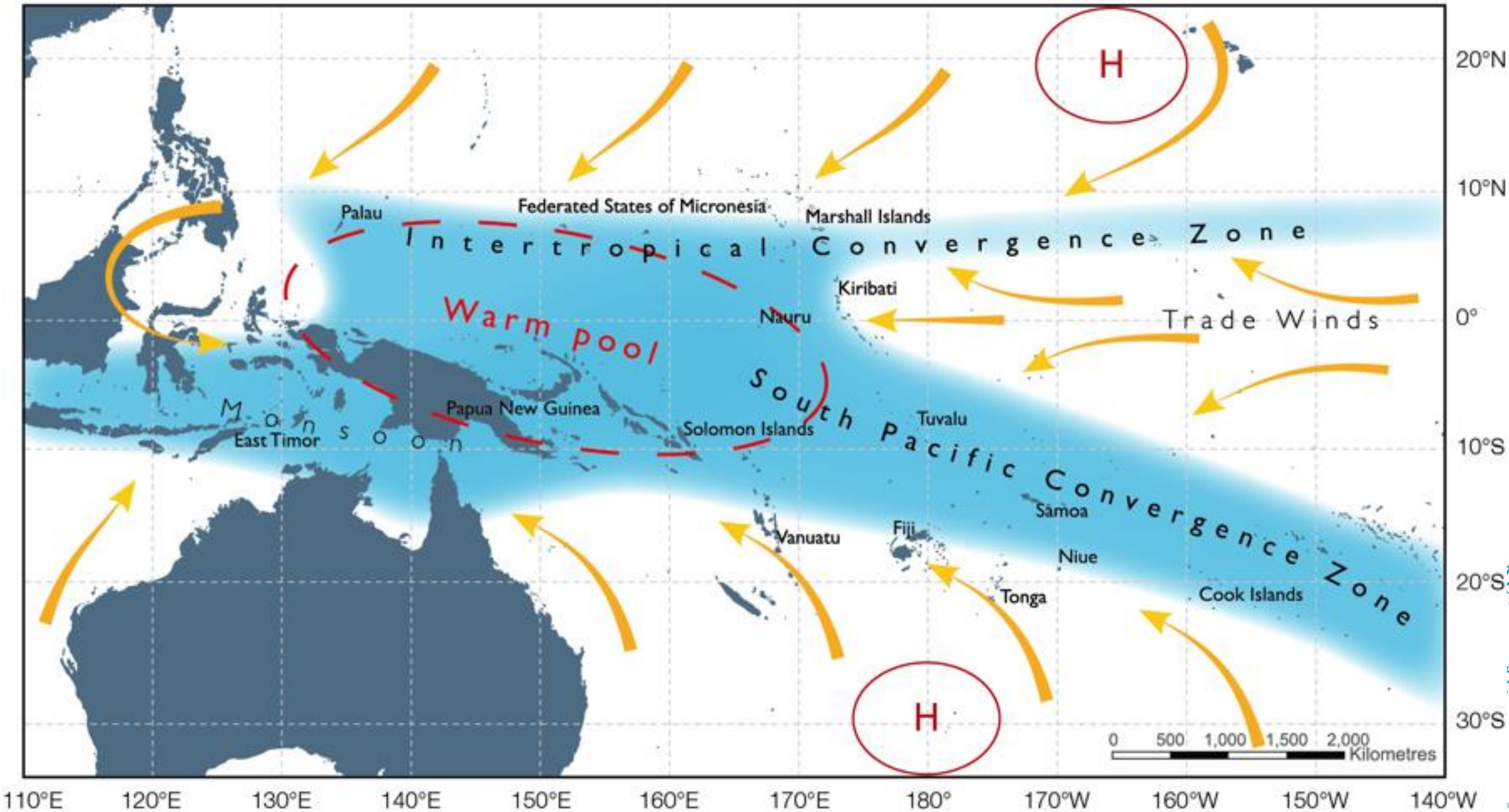

**OUR VISION**: **‘A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.’**

# Pacific region background




- Different islands size
- Different population size

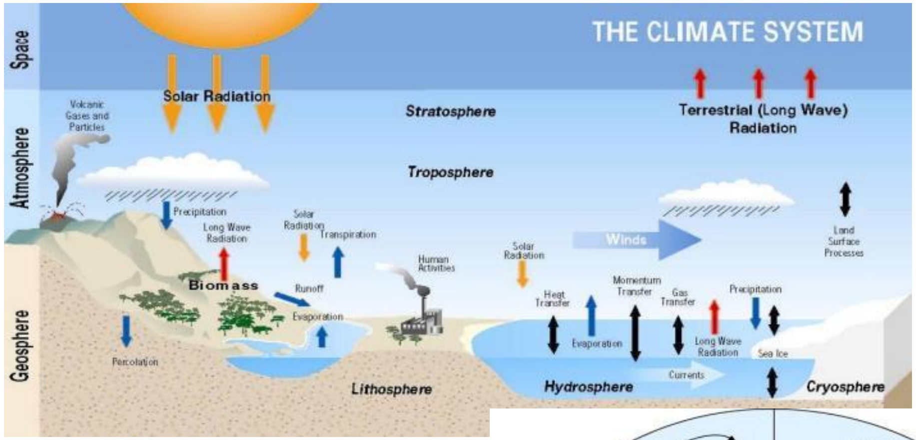
# Climate variability: Climate features in the Pacific

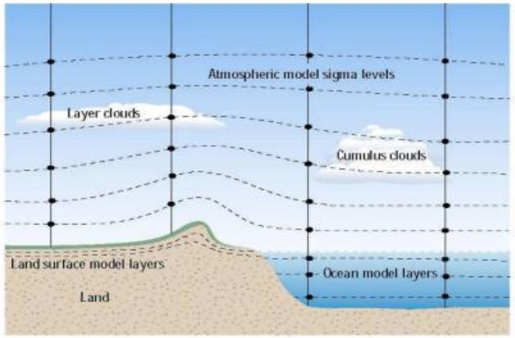


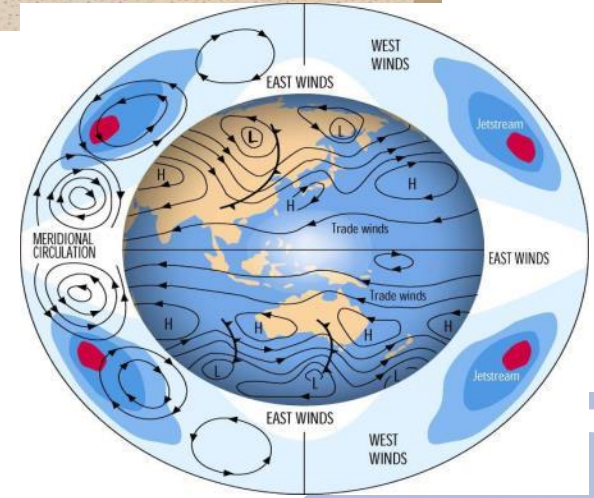
# Climate Forecasting in the Pacific Islands

-Mainly Statistical forecasting- history to forecast future

-Dynamical forecast is new – use current conditions

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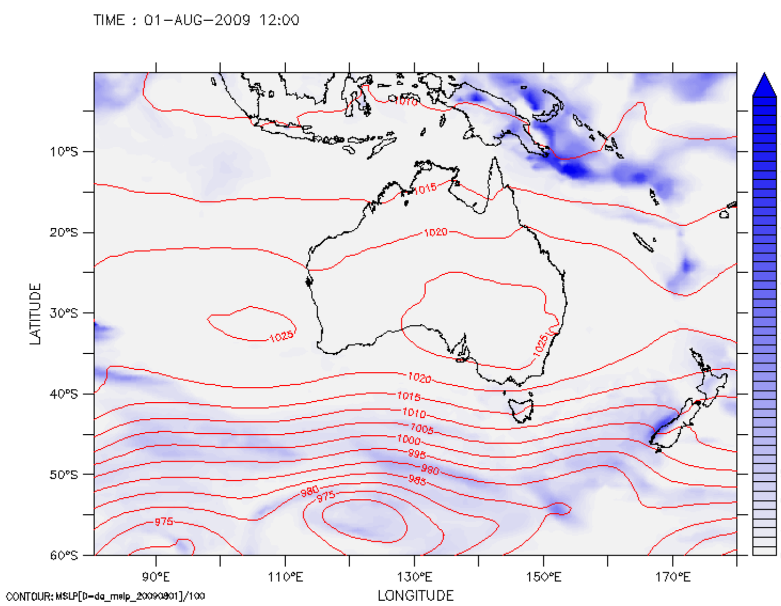
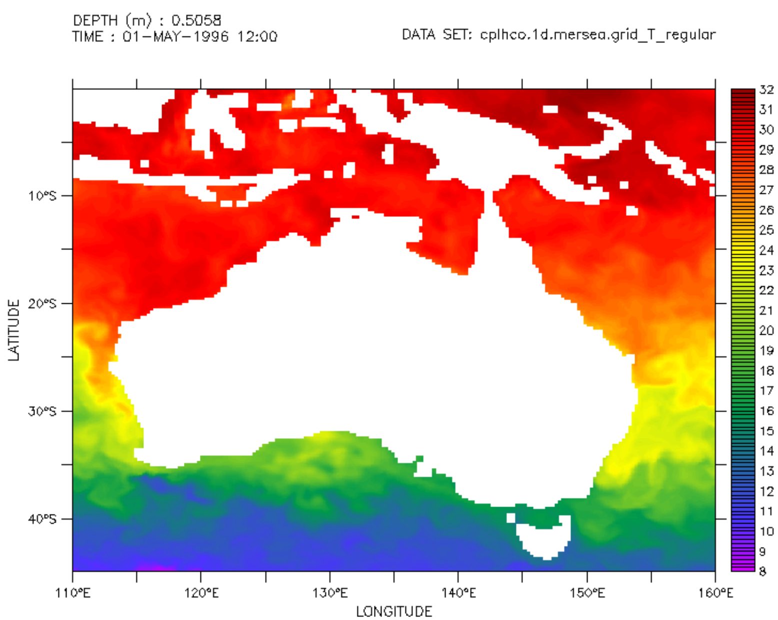
# The fundamental difference; statistical vs dynamical

- Climate models generate 'weather' several months ahead
- Run many (POAMA:165) times with different starting values
- Proportion of "wet average weather" is the seasonal outlook




precipitation (mm/day) and MSLP (mb)

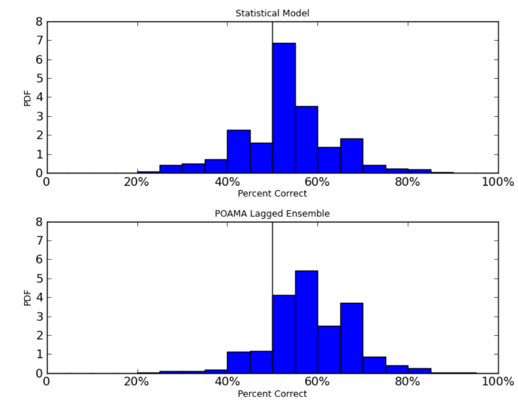



Temperature (degC)

# Dynamical better than Statistical - Australia

**Table 2** Brier skill score (BSS) with reliability (REL) and resolution (RES) components and percent consistent (PC). Scores are calculated over all grid points and seasons over Australia. POAMA-single is for a twenty day lead seasonal forecasts initialised on the eleventh of the month.

| *System* | *Period* | *BSS* | *REL* | *RES* | *PC* |
|---|---|---|---|---|---|
| Statistical | 1981-2010 | 0.3% | 0.0028 | 0.0028 | 51.7% (45.4,58.1) |
| POAMA-lagged (20 day) | 1981-2010 | 4.4% | 0.0017 | 0.013 | 55.9% (48.0,64.8) |
| POAMA-lagged (10 day) | 1981-2010 | 5.2% | 0.0015 | 0.014 | 54.0% (53.0,69.2) |
| Statistical | 2000-2011 | 2.7% | 0.0022 | 0.0078 | 58.3% (47.8,68.7) |
| POAMA-lagged (20 day) | 2000-2011 | 3.6% | 0.0063 | 0.015 | 60.1% (44.4,75.9) |
| POAMA-lagged (10 day) | 2000-2011 | 5.0% | 0.0049 | 0.017 | 64.0% (47.5,78.7) |
| Statistical | 1950-1979 | 1.3% | 0.00035 | 0.00338 | 51.2% (45.5-56.2) |
| Statistical | 1950-1999 | 0.55% | 0.00095 | 0.00228 | 50.3% (45.9-54.8) |
| Statistical | 1980-1999 | -0.77% | 0.00385 | 0.00173 | 49.1% (41.9-56.7) |
| POAMA-single 20 day | 1981-2010 | 2.6% | 0.00505 | 0.0115 | 60.1% (52.8-67.5%) |




The POAMA 20 day lead lagged ensemble, weighted mean percent consistent over Australia is 55.9% with a 95% range of 48.0%—64.8%. The statistical SCO weighted mean percent consistent is 51.7% with a 95% range of 45.4%—58.1%. The better spatial distribution of skill from the dynamical model can be seen clearly by the construction of a histogram of the

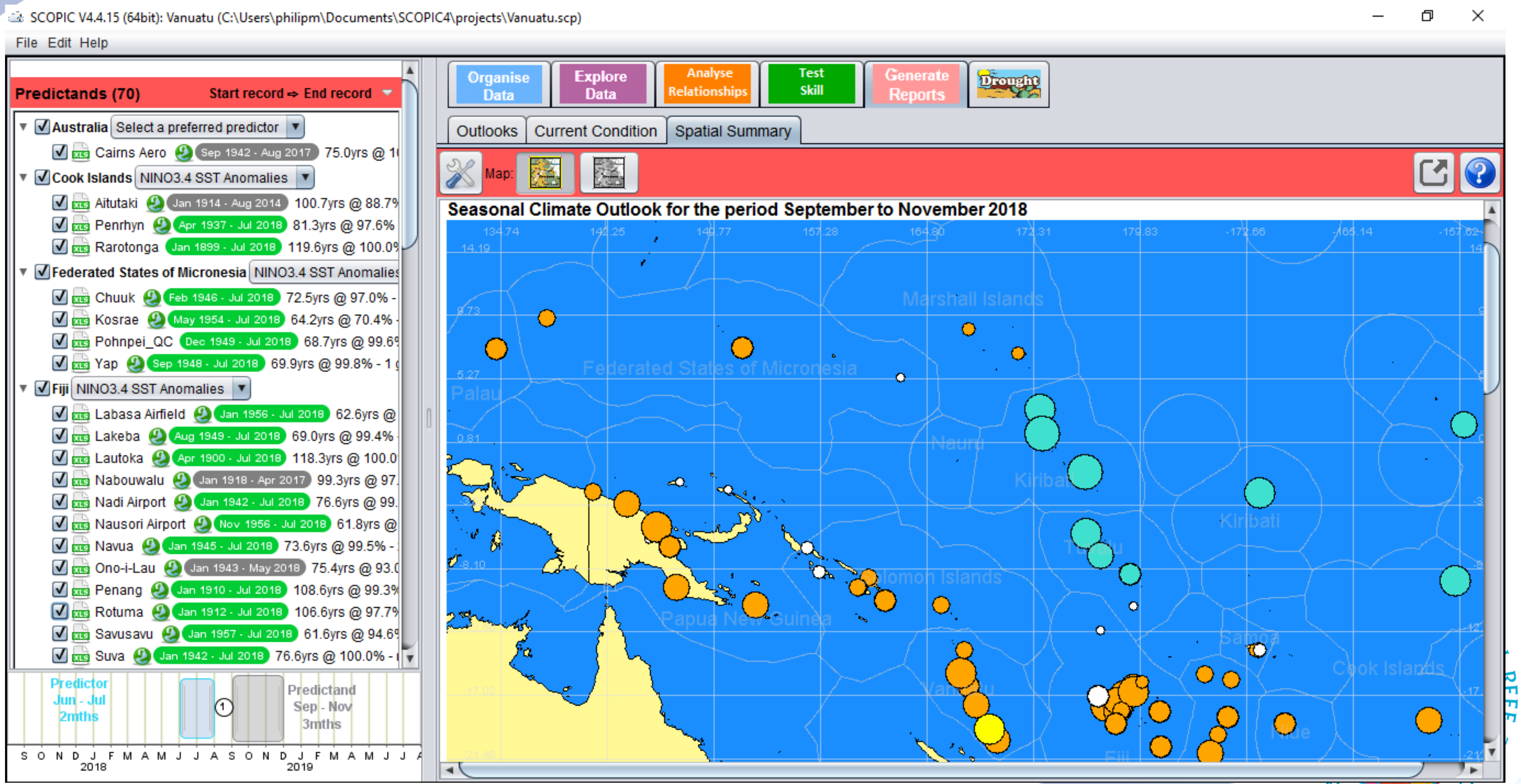
*Seasonal Forecasting for Australia using a Dynamical Model: Improvements in Forecast Skill over the Operational Statistical Model*
*AN Charles, RE Duell, X Wang, AB Watkins*
*AUSTRALIAN METEOROLOGICAL AND OCEANOGRAPHIC JOURNAL 65 (3-4), 356-375*

# Statistical climate models

# What is SCOPIC

- Seasonal Climate Outlook for Pacific Islands countries
  - is a statistical seasonal forecasting application for desktop computers, funded by Australia (DFAT)
  - Since early 2000s
  - Use historical rainfall and climate conditions (SST and SOI)
  - Predict rainfall for the next three months
  - 11 countries
  - First ever statistical model develop and use by PICs

# SCOPIC software



# SCOPIC skills

- Skill is high during wet season and low during dry season

Skill Table | Skill Calendar | Hindcasts

**Analysis:** LEPS Scores

**Cross Validated "Tercile" LEPS Scores for 3mth Predictands**

**1mth avg. NINO3.4 SST Anomalies**

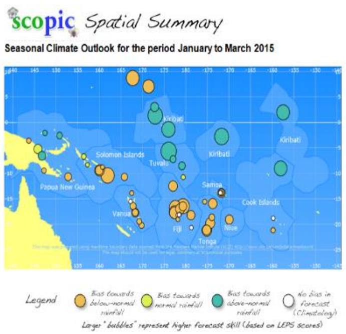
Port Moresby (69 yrs)

| Lead Time (mths) | Jan -Mar | Feb -Apr | Mar -May | Apr -Jun | May -Jul | Jun -Aug | Jul -Sep | Aug -Oct | Sep -Nov | Oct -Dec | Nov -Jan | Dec -Feb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 2.1% | 3.9% | 5.5% | 6.0% | 0.2% | 1.6% | -0.1% | -1.3% | -0.2% | -1.0% | -0.9% | -0.6% |
| 8 | 3.3% | 7.9% | 6.4% | 5.3% | -0.2% | 2.2% | -0.7% | -1.3% | -1.0% | -0.9% | -0.7% | 0.3% |
| 7 | 6.2% | 9.4% | 3.1% | 4.2% | -1.2% | 2.8% | -1.7% | -1.4% | -1.5% | -0.5% | -0.4% | 3.9% |
| 6 | 5.5% | 7.6% | 1.4% | 3.9% | -1.1% | 4.0% | -1.8% | -1.3% | -1.8% | 1.9% | 2.0% | 3.4% |
| 5 | 3.9% | 5.2% | 0.0% | 4.9% | -0.2% | 5.8% | -1.8% | -1.3% | -1.0% | 8.1% | 5.2% | 2.5% |
| 4 | 3.4% | 5.9% | 0.8% | 4.7% | 0.6% | 9.6% | -1.8% | -1.4% | 3.1% | 14.1% | 7.8% | 5.5% |
| 3 | 3.2% | 6.7% | 1.1% | 6.7% | 3.3% | 10.2% | -1.9% | -1.3% | 8.6% | 19.4% | 9.2% | 11.0% |
| 2 | 3.2% | 8.1% | 2.3% | 8.9% | 3.2% | 9.7% | -2.0% | -1.5% | 14.5% | 21.4% | 16.1% | 12.0% |
| 1 | 3.9% | 11.3% | 3.8% | 9.7% | 3.8% | 8.2% | -1.8% | -1.4% | 14.9% | 26.4% | 15.7% | 10.7% |
| 0 | 4.7% | 12.9% | 4.8% | 9.9% | 2.4% | 7.9% | -1.4% | -1.8% | 17.8% | 24.3% | 16.3% | 10.3% |

Worse than climatology | As good as than climatology | Better than climatology

# SCOPIC activities

- SCOPIC successfully transitioned to SPREP
  - SCOPIC version  4.4.15 distributed to all countries
  - Regional training including Palau, FSM, Nauru and Tokelau – September 2017
  - SCOPIC Drought monitoring training for Solomon Islands, PNG, Fiji and Vanuatu to link to drought plan




PACIFIC YEAR OF THE CORAL REEF
HEALTHY REEF, HEALTHY PEOPLE

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# SCOPIC activities

- Online Climate Outlook Forum (OCOF) - transitioned to SPREP
  - Data agreement by all countries except three
  - Monthly teleconference hosted by SPREP
  - Monthly review of OCOF tables
  - Regional and In-country training
  - PICOF 3 - Climate and Health
  - Teleconference facilities for SPREP

| Station (include data period) | | | November 2017 | | | | |
|---|---|---|---|---|---|---|---|
| | September 2017 Total | October 2017 Total | Total | 33%tile Rainfall (mm) | 67%tile Rainfall (mm) | Median Rainfall (mm) | Ranking |
| Auki (1962 – 2017) | 360 | 226 | 214 | 175 | 263 | 223 | 27/54 |
| Henderson (1975 – 2017) | 118 | 57 | 168 | 102 | 192 | 141 | 24/43 |
| Honiara (1954 – 2017) | 181 | 67 | 205 | 175 | 263 | 223 | 27/54 |
| Kirakira 1965 – 2017) | 227 | 224 | 286 | 172 | 267 | 200 | 46/50 |
| Lata (197 5– 2017) | 559 | 728 | 464 | 268 | 418 | 365 | 32/43 |
| Munda (1962 – 2017) | 239 | 176 | 272 | 181 | 280 | 235 | 37/56 |
| Taro (1975– 2017) | 276 | 390 | 185 | 203 | 293 | 237 | 12/40 |

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# Dynamical climate models

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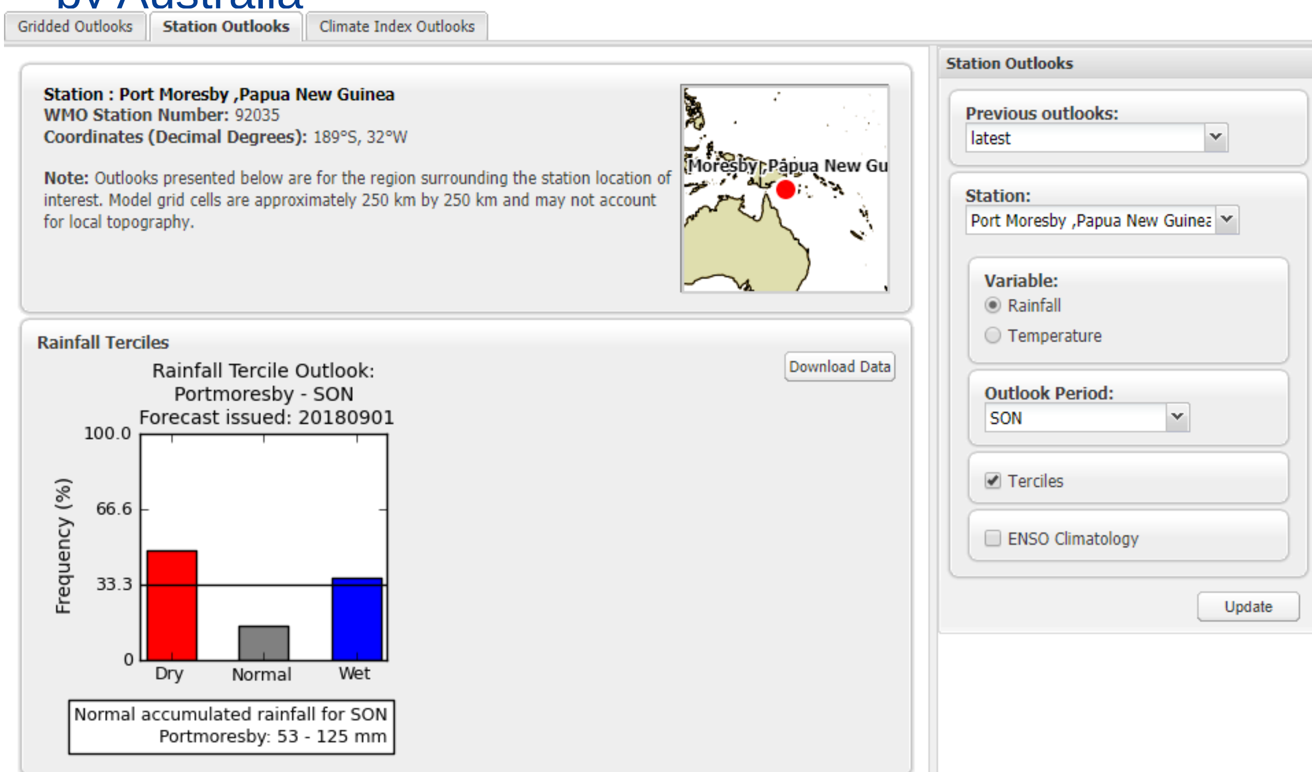
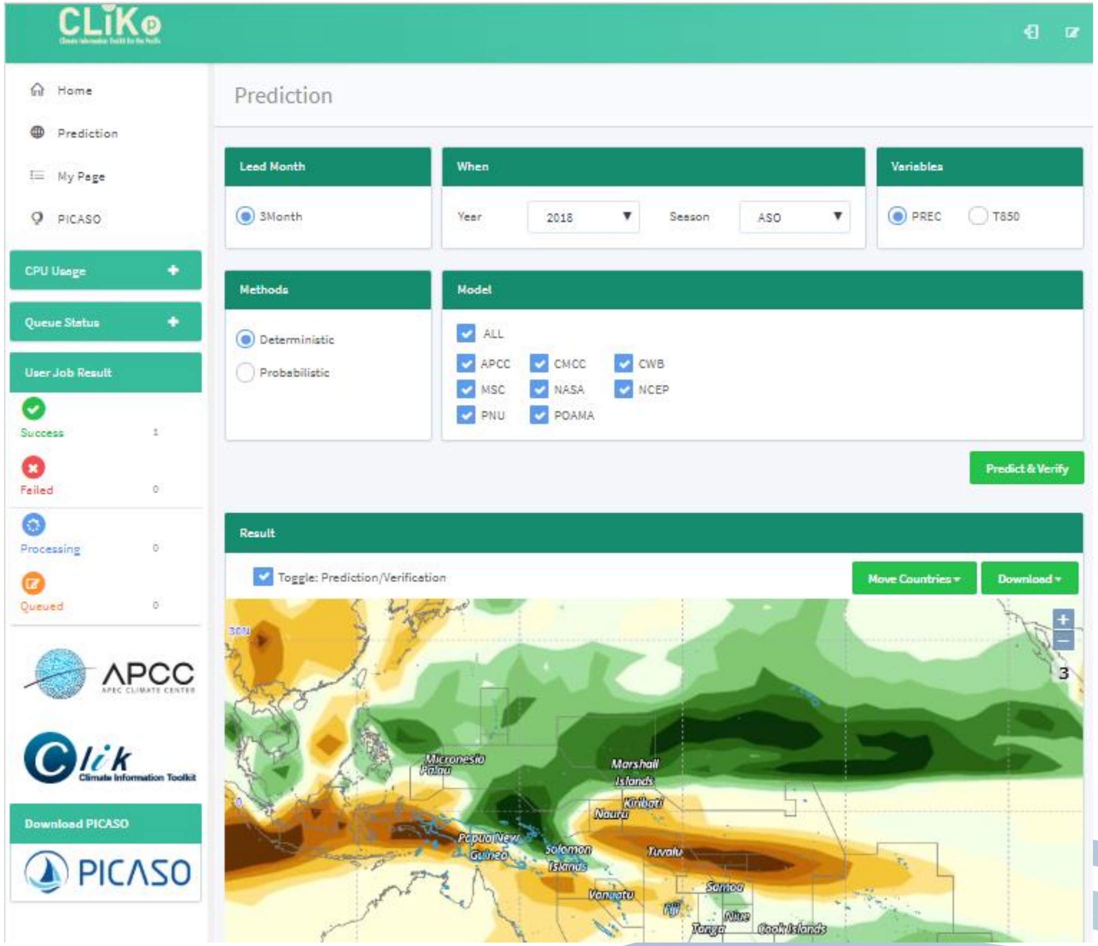
# Dynamical Models

- There were 3 main models use in the Pacific

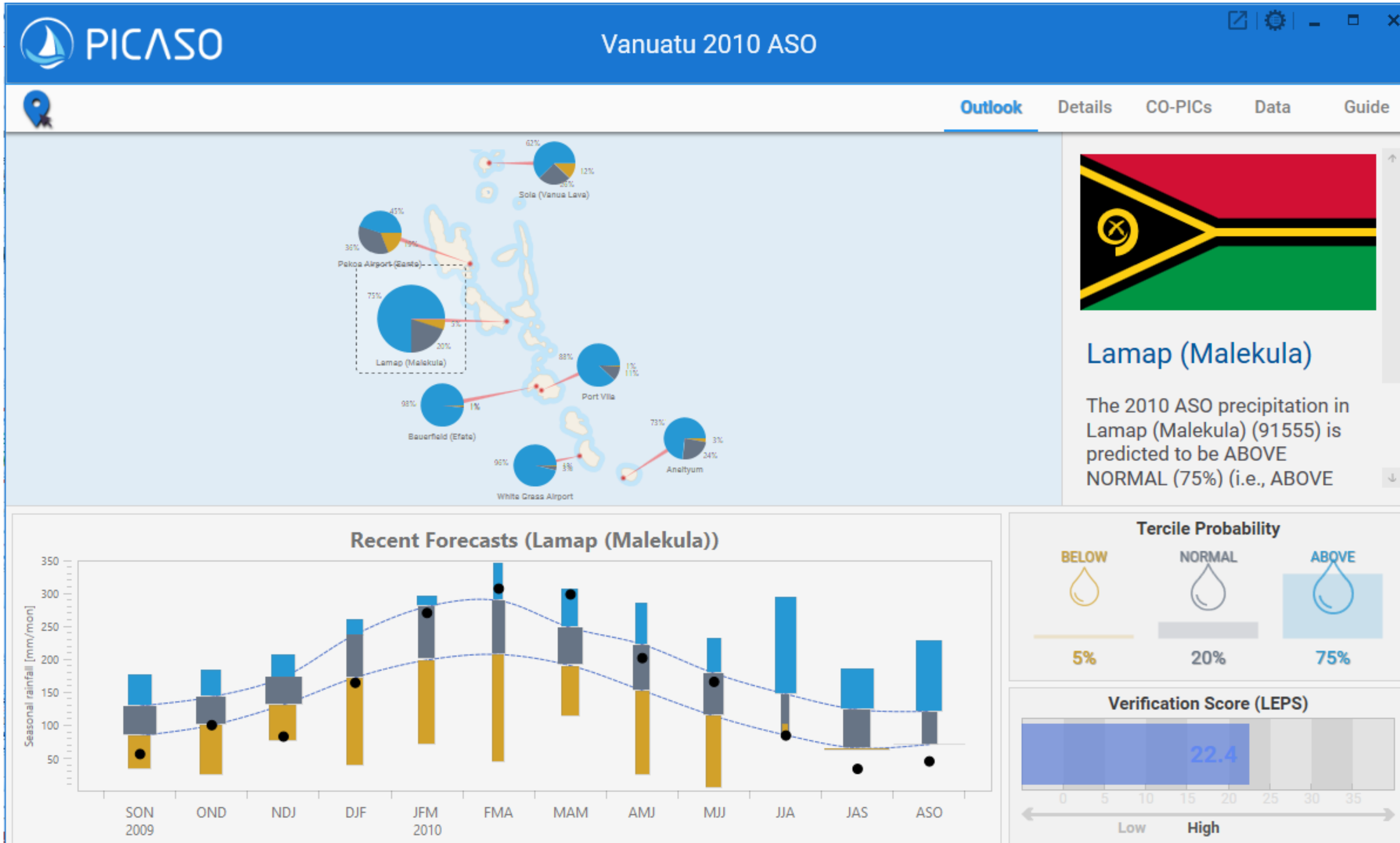
1. Poama (Predictive Ocean-Atmosphere Model for Australia)– Developed by Australia



1. Clik-P -**CL**imate **I**nformation Tool**K**it for the **P**acific developed by Republic of Korea



# 3. PICASO – Pacific Island Advance Seasonal Outlook developed by Republic of Korea



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# What is CLIK-P?

# CLIK-P

- **CL**imate **I**nformation Tool**K**it for the **P**acific

http://clikp.sprep.org

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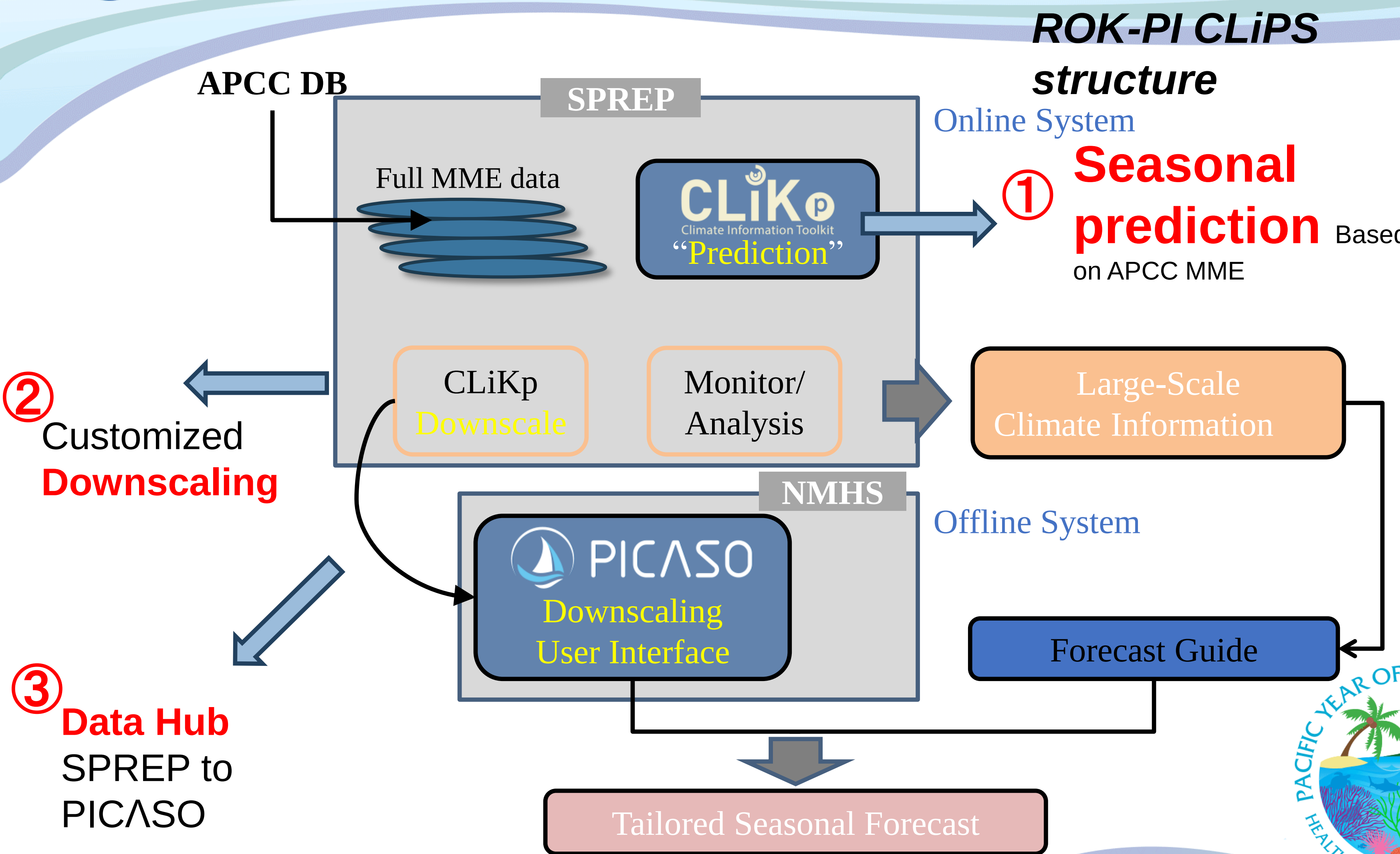
# Mission of CLIK-P!




*CLIK-P was developed to provide customized seasonal prediction based on APCC MME!*

# CLIK-P Mission!!!

- Seasonal prediction based on APCC MME.
  (It focused on Pacific Islands regions.)
  *Users can get the focused seasonal prediction easily.*

- Customized downscaling toolkit.
  (But, it doesn’t display on the CLIK-P.)
  *CLIK-P just calculate and save the tailoring results.*

- Data hub to connect PICΛSO and SPREP.
  (PICΛSO display the tailoring results.)

*Although PICΛSO designed off-line tailoring toolkit, PICΛSO needs some network connection to receive the downscaled results.*

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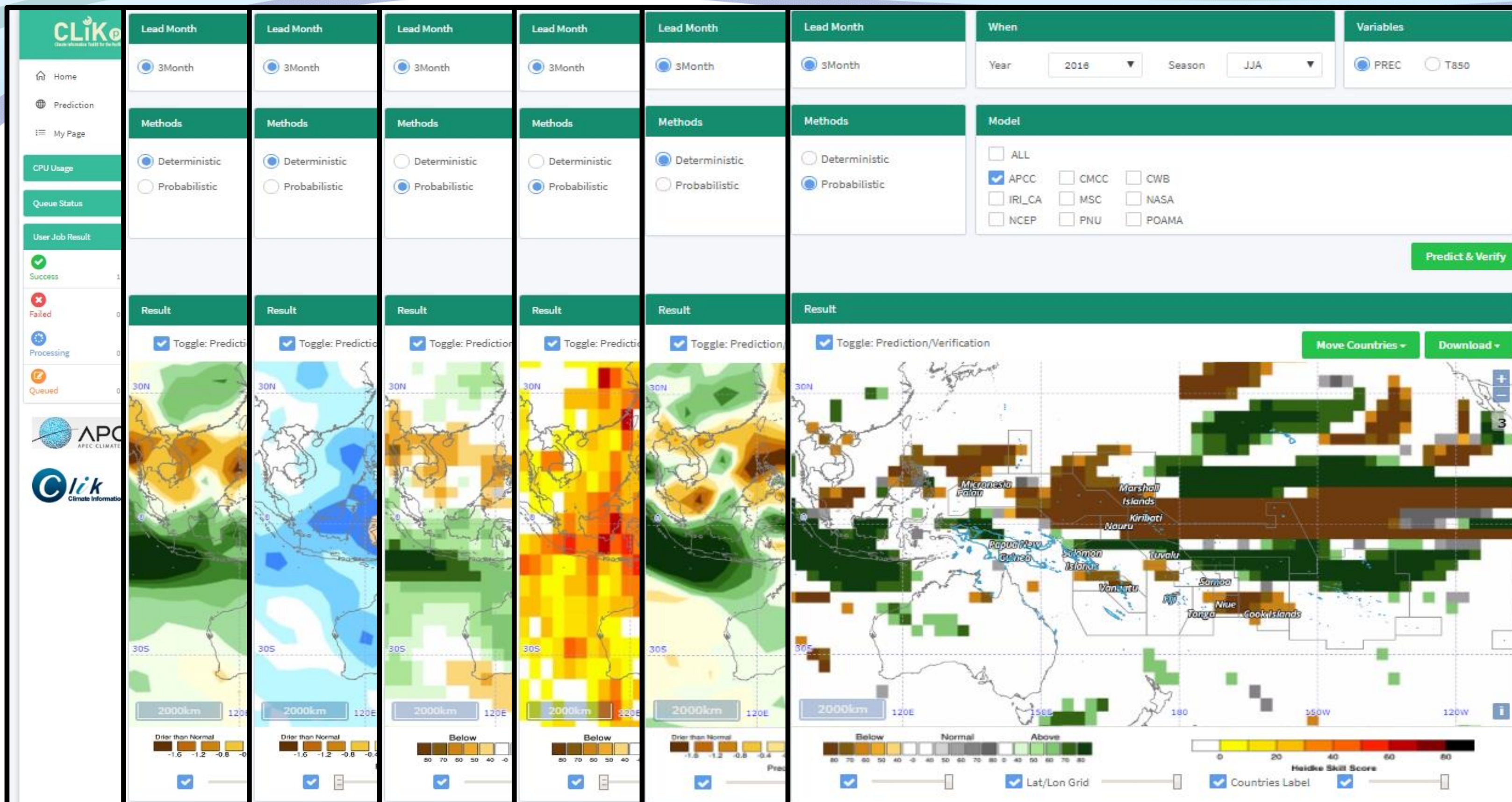
# CLIK-P




- Can combine a suitable dynamical models according to users' taste
- Precipitation/Temperature

# PICASO

- PICASO – **P**acific **I**sland **C**ountries **A**dvanced **S**easonal **O**utlook
- Developed by the Republic of Korea through APCC
- Use since 2017

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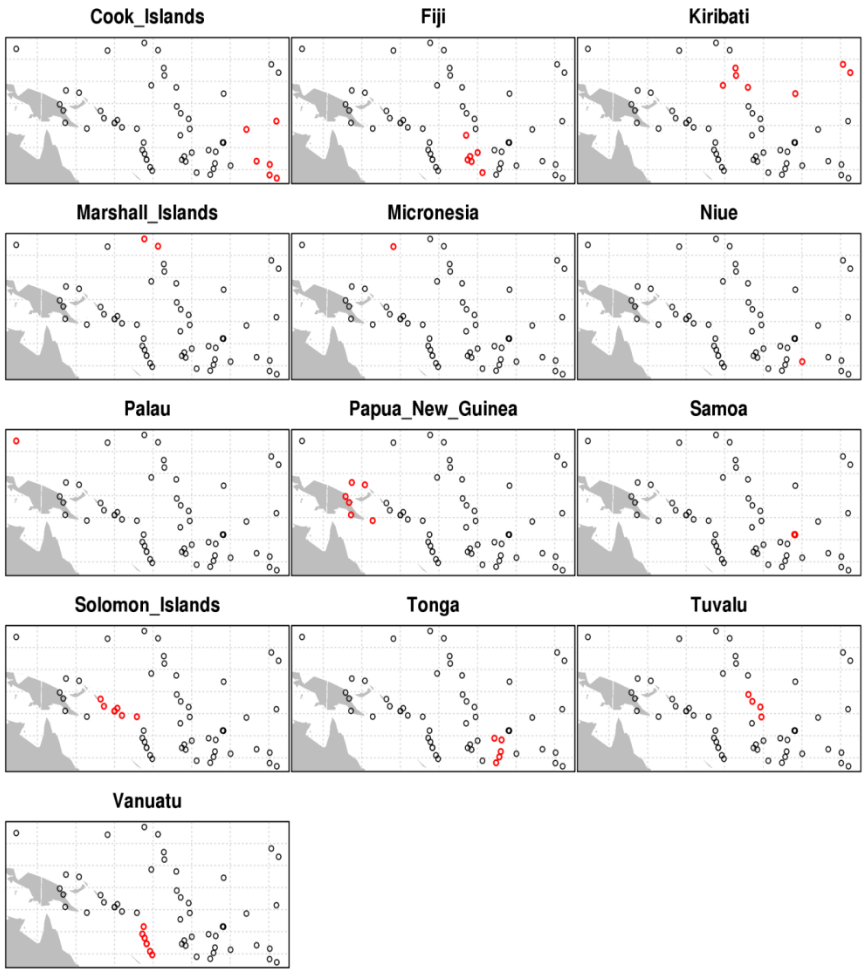
# 49 Pacific Observing Stations (PICASO)

- Which stations are downscaled in PICASO system?




| Country | Station | Country | Station |
|---|---|---|---|
| Cook Islands | Penrhyn | Solomon Islands | Auki |
| | Rarotonga | | Honiara |
| Fiji | Nabouwalu | | Honiara Henderson |
| | Nadi Airport | | Kira Kira |
| | Rotuma | | Munda |
| | Udu Point | | Santa Cruz |
| | Ono I Lau | | Taro Island |
| | Suva | Tonga | Haapai |
| Kiribati | Butaritari | | KeppelMata ' aho Airport |
| | Kanton | | Lupepau ' u |
| | Kiritimati | | Niuafoou |
| | Tawara | | Nuku ' alofa |
| Marshall Islands | Kwajalein Bucholz Aaf | Tuvalu | Funafuti |
| | Majuro | | Nanumea |
| F.S. Micronesia | Pohnpei | | Niulakita |
| Niue | Hanan Airport | | Nui |
| Palau | Koror | Vanuatu | Aneityum |
| Papua New Guinea | Kavieng | | Bauerfield (Efate) |
| | Madang | | Lamap (Malekula) |
| | Misima | | Pekoa Airport (Santo) |
| | Momote | | Port Vila |
| | Nadzab | | Sola (Vanua Lava) |
| | Port Moresby | | White Grass Airport |
| Samoa | Afiamalu | | |
| | Faleolo | | |
| | Apia | | |

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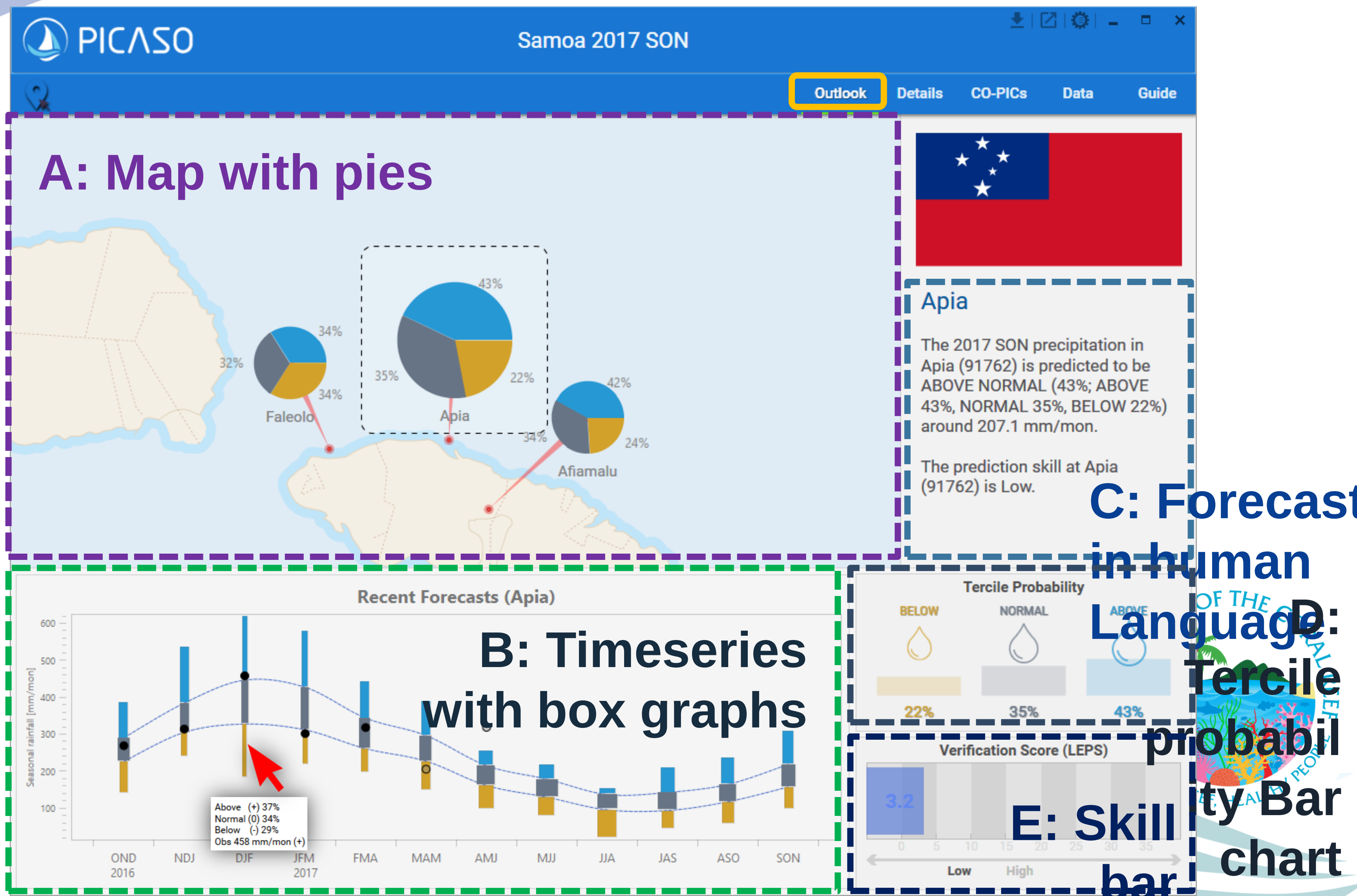
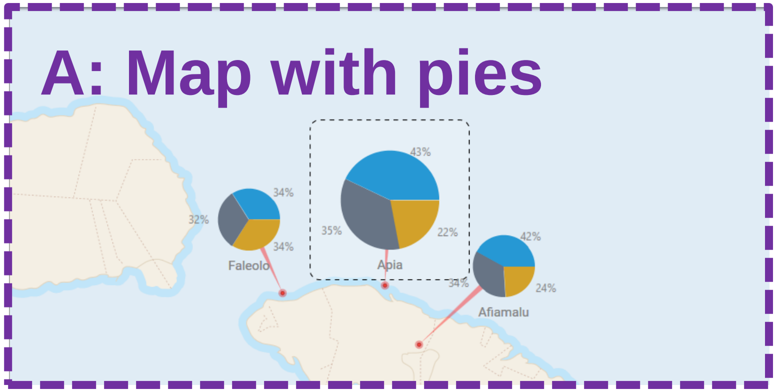
# PICASO Outlook

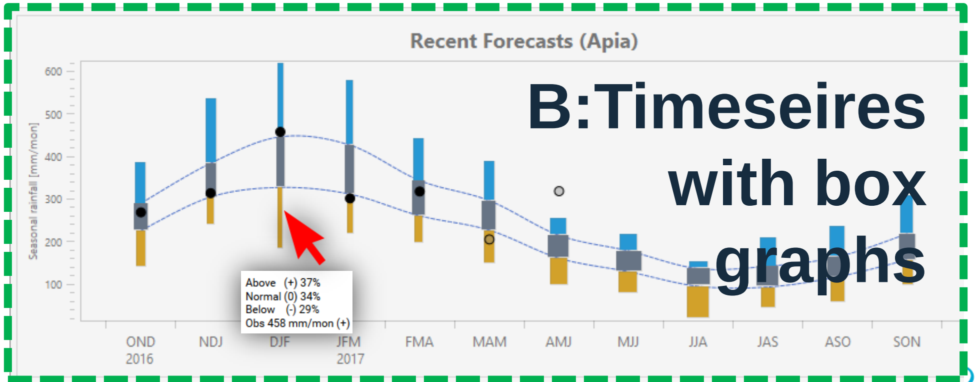


# PICASO Outlook provides…

## Spatial distribution of forecast (over a country in a target season)

## Temporal variation of forecast (in recent 12 seasons at a target station)




- Box top/bottom: upper and lower 5% value of forecast distribution
- Box extent: probability of AN/NN/BN
- Circles: observed rainfall
- Lines : Lower/upper terciles

# Dynamical better than Statistical

## Conclusions

- Statistical modelling, where the skill is increasingly difficult to gauge due to a changing climate, offers little opportunity to see significant improvements in seasonal forecast accuracy.
- Statistical models which assume a stationary climate should be viewed cautiously.
- Future increases in accuracy are likely with dynamical modelling as new science, better modelling techniques, more observations and greater computer power are introduced.

*Seasonal Forecasting for Australia using a Dynamical Model: Improvements in Forecast Skill over the Operational Statistical Model*
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# Traditional Knowledge (TK) in weather and climate

# Why traditional knowledge?

- Way of living for PICs community
- Communication to reach last mile
- Level of knowledge to understand the scientific information from National Met Services (NMS)

# Traditional Knowledge – Project

- Funded by DFAT
- 5 countries (Vanuatu, Solomon Islands, Niue, Samoa, Tonga)
- Interest from other countries

# Aim of TK project

- Collections of stories on use of TK on weather and climate in the Pacific
- Validate the TK indicators
- Monitor the indicators
- Combine TK and modern science

# Progress and Transition of the Traditional Knowledge Project


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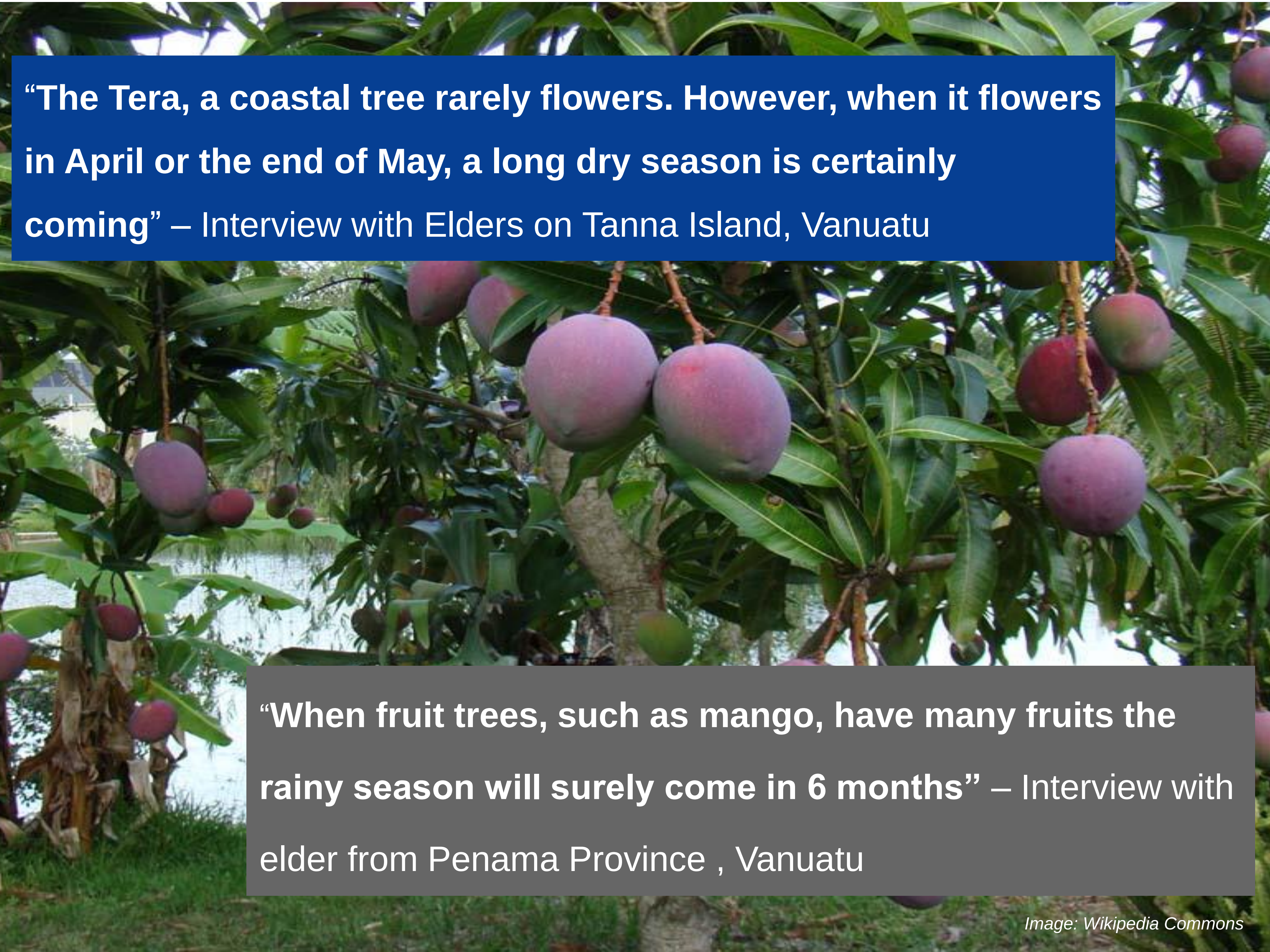
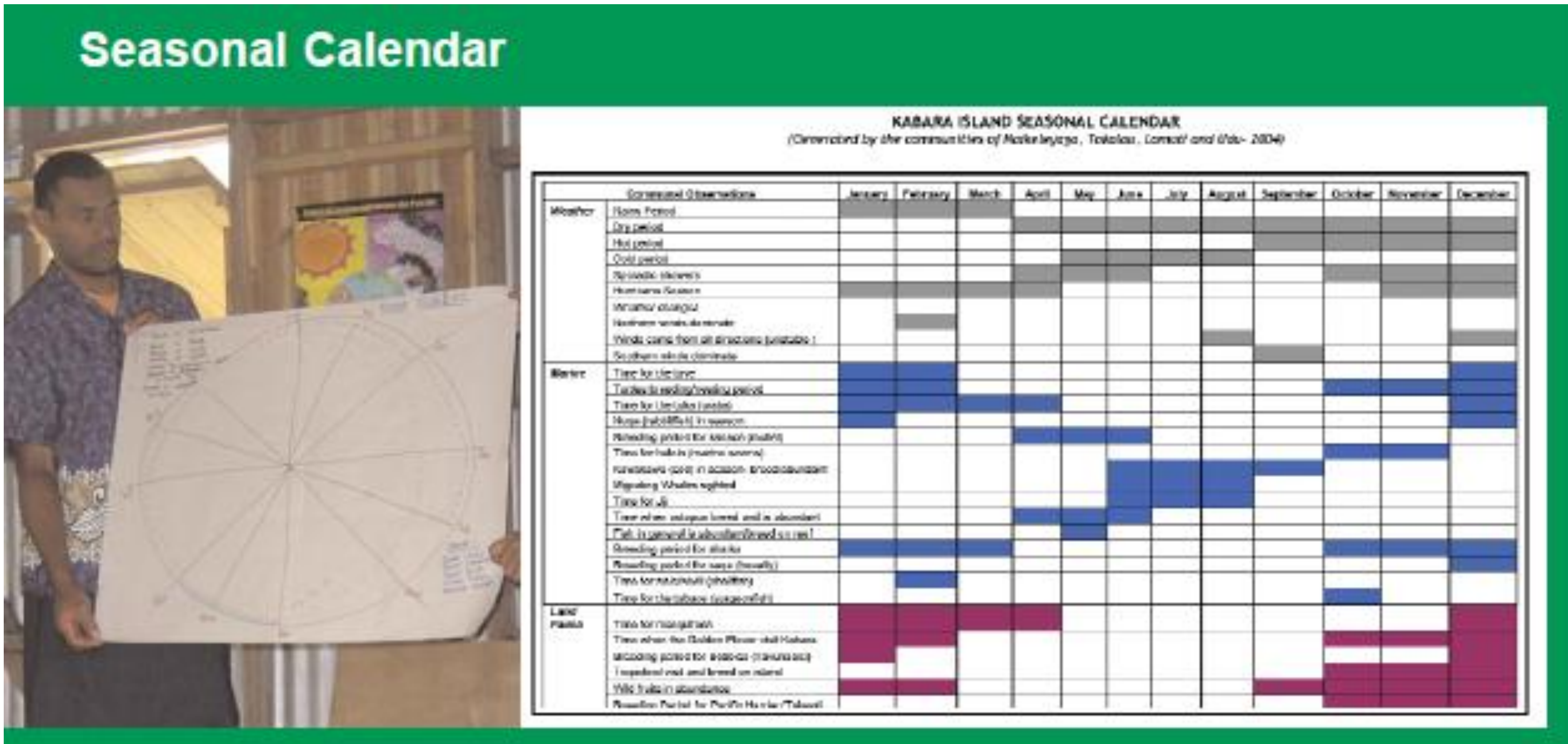



*Image: Wikipedia Commons*

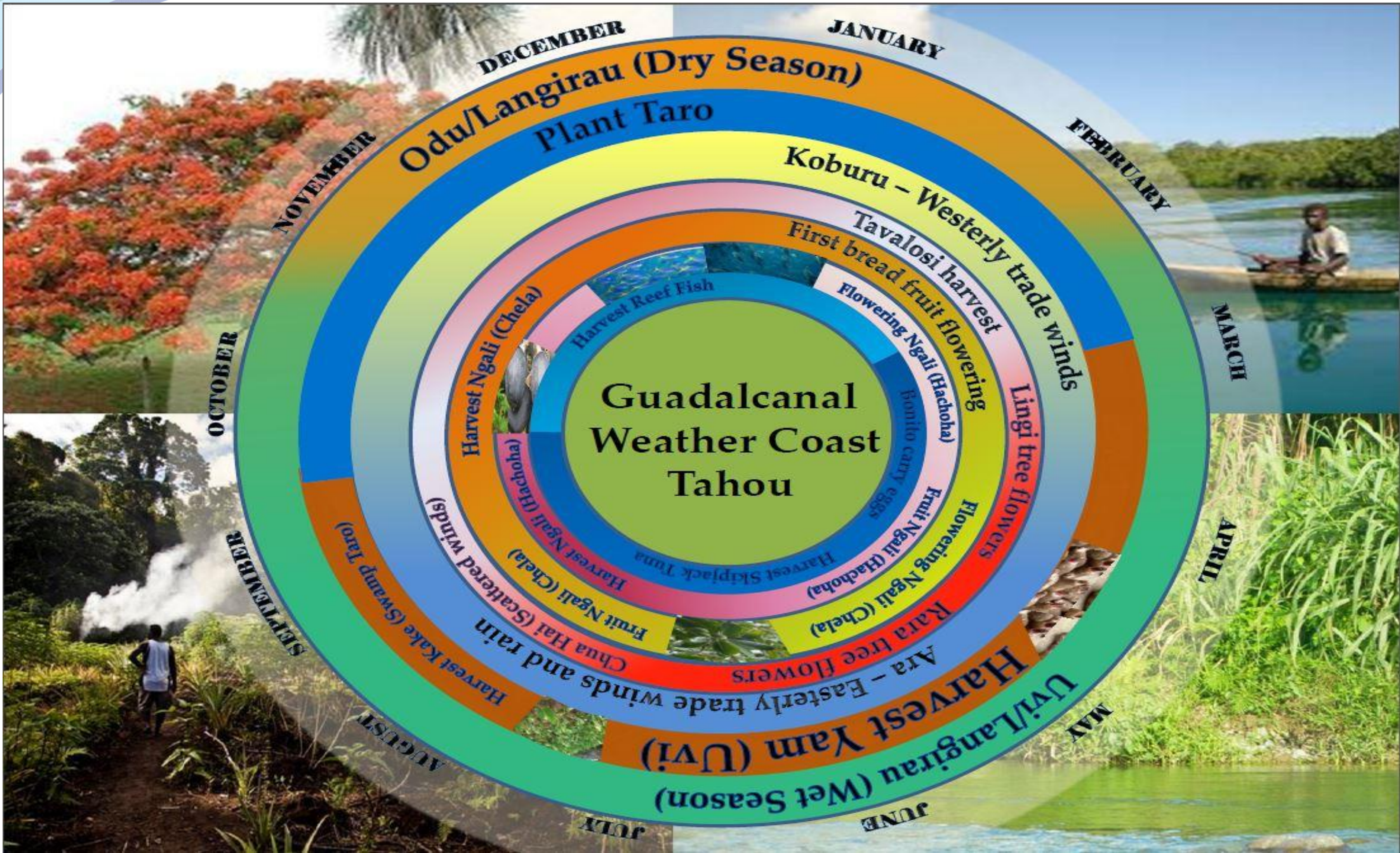
# Communication tools and products



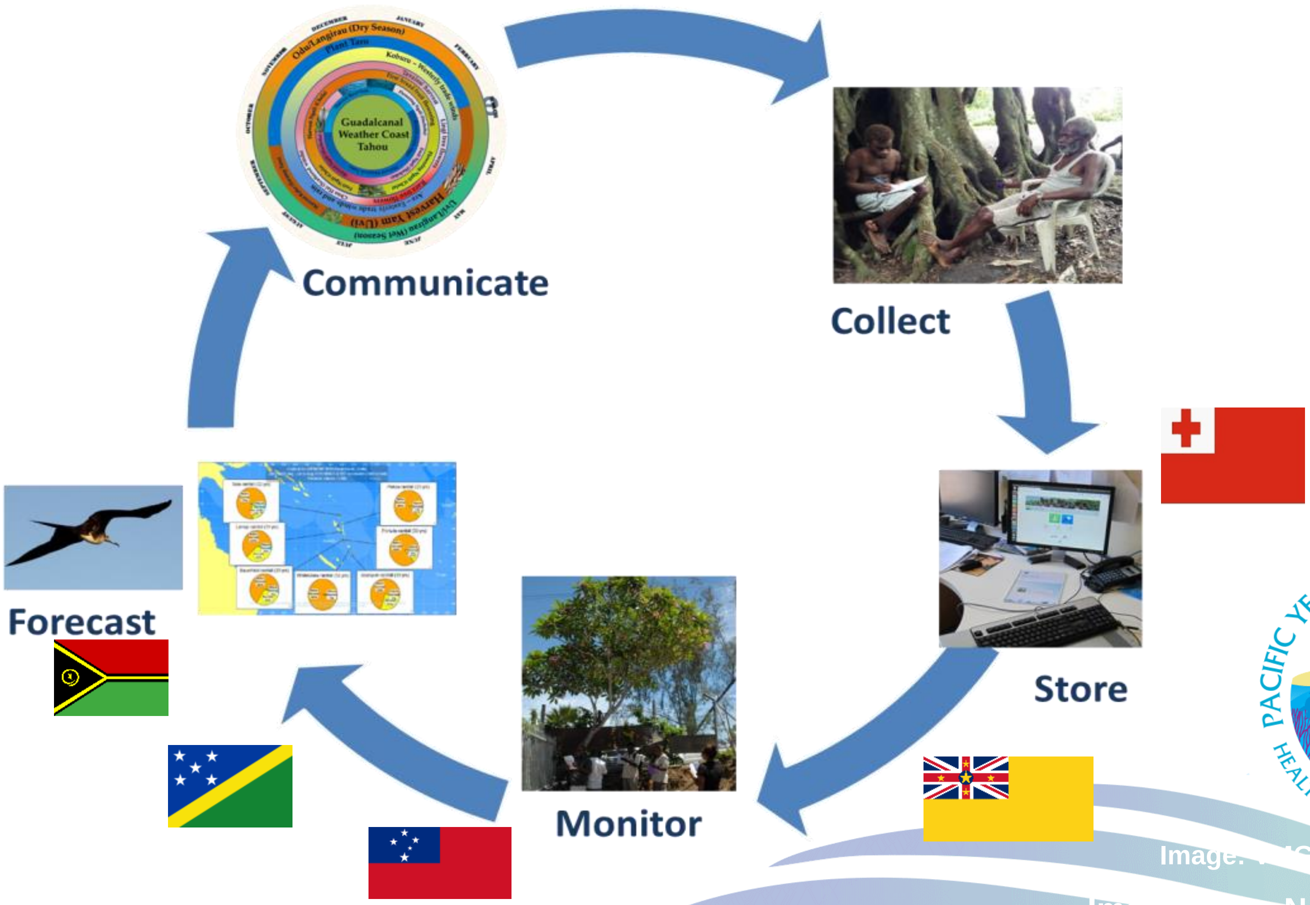

Kabara, Fiji example: WWF

# Communication tools and products

## Solomon Islands



# Project stages



# Traditional Knowledge and NMS forecasts

| Season and location | TK summary report and indicators | NMS forecast | Integrated Report | Performance of integrated forecast |
|---|---|---|---|---|
| March-May 2010<br><br>Same, Tanzania | Frogs making a lot of noise, ants moving and spreading across roads signify rainy season about to start. TK indicators show rains during this season will decrease especially in May | Seasonal rainfall will be normal. Main indicators include sea surface temperatures of the Indian and Pacific Oceans and wind strength | TK and NMS forecasts indicate normal rains, expected to decrease as the season progresses | Reported as "very good" – almost all predicted events came to pass |

Source: Ziervogel & Opere 2010

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# Communication and Project Awareness Raising


Mr. Espen Ronnerberg at the 9th Research Dialogue during the International Climate Change Meeting in Bonn, Germany. Photo: SPREP

## COSPPAC traditional knowledge poster presented at Climate Change meeting in Bonn

SPREP was invited to participate in the 9thresearch dialogue during the international Climate Change Meeting in Bonn, Germany. Work undertaken on mapping and understanding traditional knowledge for climate and weather prediction had been developed into a poster by SPREP staff Siosinamele Lui and was presented by Espen Ronneberg.

READ MORE ...


Photo: Siosinamele Lui/SPREP

## Stakeholders join the Met Office to collect traditional knowledge

The Tongan Meteorology Department today joined with various stakeholders from the Community, Private Sector, other Government Agencies and Non-government agencies for a 2 day workshop on collecting and documenting weather and climate related traditional knowledge. The workshop is funded by the Government of Australia under the Climate and Ocean Support Program for the Pacific (COSPPAC) initiative and implemented by the Australian Bureau of Meteorology, SPREP and the Tonga Meteorological Service.

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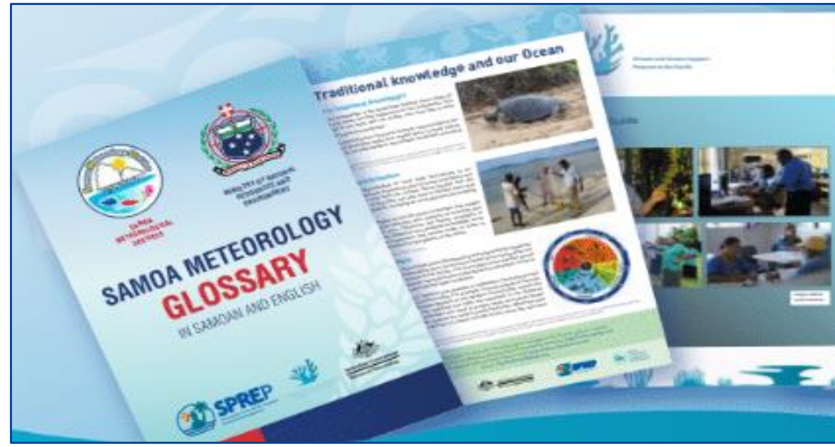
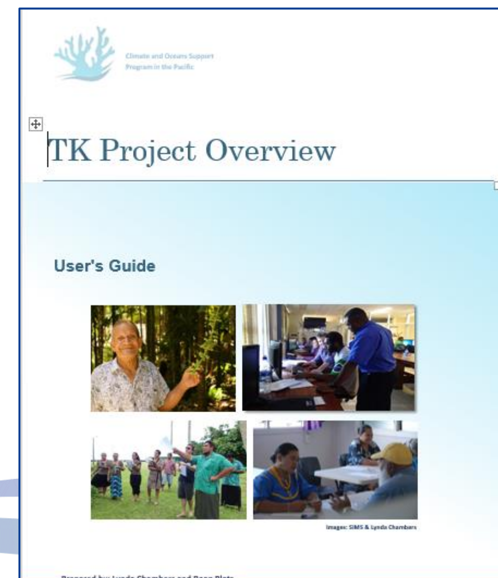
# TK Resources





# Resources

Digital Cameras,
Voice recorders
Video Cameras
Water proof Canvas

# Tonga

- Attachment
  - Tonga Met TK Lead
  - Tonga Met IT
- National TK Survey Workshop
- TK Database Installation
- TK Database Training
- Data Collection

# Samoa

- Samoa Glossary
- Verification Workshop with Elders
- Forecast Verification
- Combination  Verification Training
- Write shop
- Data Collection and Monitoring

# Vanuatu

- TK Forecast Verification and Integration verification training
- TK Database Refresher training
- TK Monitoring Refresher training
- Data Collection

# Solomon Islands

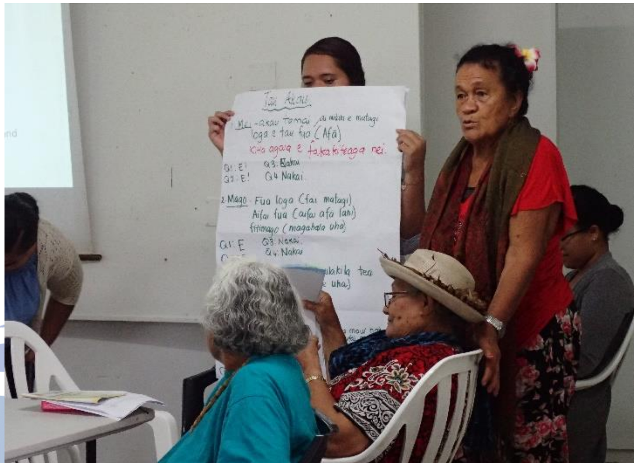
- Forecast Verification and
- Combination Training

- Refresher Database Training

- User Guides and Resources


# Niue

- Launch of Resource Materials
- National TK Verification Workshop
- TK Database Refresher training
- TK Calendar Development training with stakeholders
- TK Survey and Data collection
  - High school students



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# Scientific Papers and Communication

- TK Database paper (Published)
  - Community engagement
  - Combined Forecast methodology (publish
  - Seasonal Calendar
  - Forecast use paper

**Protocols and partnerships for engaging Pacific Island communitie**
**in the preservation of traditional climate knowledge**

Philip Malsale[1,6*], Noel Sanau[2], Tile I.Tofaeono[3], Zarn Kavisi[4], Albert Willy[1], Ros
Mitiepo[5], Siosinamele Lui[6], Lynda E. Chambers[7] and- Roan D. Plotz[7]

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METEOROLOGICAL APPLICATIONS
*Meteorol. Appl.* (2017)
Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/met.1648

RMetS
Royal Meteorological Society

**A database for traditional knowledge of weather and climate in the Pacific**

Lynda E. Chambers,[a] Roan D. Plotz,[a*] Tom Dossis,[a] David H. Hiriasia,[b] Philip Malsale,[c] David J. Martin,[a] Rossy Mitiepo,[d] Khadiza Tahera[a] and Tile I. Tofaeono[e]

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**ABSTRACT:** Growing interest in traditional knowledge (TK), particularly in relation to the prediction of weather or climate extremes, raises issues concerning the appropriate storage and management of the information collected. The Traditional Knowledge Database (TK Database) for the storage and use of TK associated with weather and climate prediction in the Pacific was designed with the following principles in mind: (1) preservation of the knowledge, maintaining cultural context wherever possible; (2) respect for intellectual property and cultural sensitivities around data sharing and use; (3) appropriate system design, accounting for ongoing costs of system maintenance and often intermittent Internet access; and (4) moving beyond data preservation to ensure continued use and growth of the TK. The TK Database was successfully deployed to four countries in the south Pacific and is regularly used by their national meteorological services, and partner organizations, both to preserve TK related to weather and climate and as a tool to assist in monitoring the TK indicators. As the first database of its kind, the TK Database fills a critical gap in the appropriate storage and application of TK and provides an important foundation for future developments.

KEY WORDS Oceania; indigenous knowledge; Vanuatu; Samoa; Niue; Solomon Islands; digital rights management; environmental monitoring; database management

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# Partnership and Opportunities with SPREP

- Pacific Meteorological Council (PMC) – provide guidance and direction on weather and climate activities
- Pacific Met Desk and Partnership carry out activities with NMS
- Regional Climate Centre – virtual centre for climate forecasting (Models)- different nodes with different institutions
- Pacific Climate Change Centre –Training and research
- Research – Weather and climate in the Pacific
- Weather and climate activities/Projects
- Traditional Knowledge activities/Project

# Challenges and what for the Future?

- Use high resolution models
  - ACCESS-S (DFAT)
- Data sharing
- More observing sites (Land and sea)
- Combination of traditional knowledge and modern science for weather and climate forecasting

SPREP
Secretariat of the Pacific Regional Environment Programme

# Thank you

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