Regional Climate Science for the Pacific

John Clarke, Tim Erwin, Geoff Gooley & Kevin Hennessy

......on behalf of PACCSAP Science Program (CSIRO & Bureau of Meteorology), incl. collaborative partners in Australia & the Pacific

Pacific-Australia Climate Change Science and Adaptation Planning Program
Presentation Outline

• Overview - PACCSAP Science Program
• Overview - new science, tools, communication & capacity development
• Decision-centred approach to adaptation
• Delivering climate science-based evidence
• Data and information management
• Post-PACCSAP future
PCCSP/PACCSAP Science

- Pacific Climate Change Science Program (PCCSP)
  - ~$20m over ~ 2.5 yrs (2008/09-2010/11)

- Pacific – Australia Climate Change Science & Adaptation Planning (PACCSAP) Science Program
  - ~$20m over ~ 2.5 yrs (2011/12-2013/14)

- Funded & administered by Australian Government:
  - Dept Foreign Affairs & Trade (DFAT) and Dept of Environment (DoE)

- Delivered by Centre for Australian Weather & Climate Research (CAWCR):
  - partnership between CSIRO and Bureau of Meteorology (BOM)

- 15 diverse partner countries & numerous regional organisations and universities incl. SPREP, SPC, USP, Red Cross and GIZ

- Other Australian agencies: Geoscience Australia, ARC Centre of Excellence for Climate System Science
PCCSP/PACCSAP Science

- Regional focus on 14 Pacific Island Countries (PICs) + Timor-Leste
  - key stakeholders - National Met Services
- Response to considerable PIC needs (demand driven, next/end user focus)
- Data/information (knowledge), tools and capacity to facilitate decision-making & associated pathways to adaptation
PACCSAP Science – strategic drivers

• PACCSAP – two components:
  – Adaptation Component (DoE)
  – **Science Component (CSIRO & BOM)**

• PACCSAP goal & objective:
  – PICs developed capacity to monitor & adapt to changing natural environment, & enhanced resilience to impacts of climate change
  – Emphasis on PIC scientists, decision-makers & planners to apply info/tools & develop in-country responses

• **PACCSAP Science component objective:**
  – Primary: Improve scientific understanding of climate change in the Pacific
  – Together with DoE:
    • Increased awareness of climate science, impacts and adaptation options
    • Better adaptation planning to build resilience to climate change impacts
PACCSAP Science Program - Scope

- **New science**
  - Seasonal predictions & climate data (data rescue, digitisation & management)
  - Large-scale climate features & variability
  - Regionally specific projections & extreme events
  - Ocean processes

- **Tools development & technical support**
  - Pacific Climate Futures
  - CliDE data management system
  - Data portals

- **Communication products**
  - Technical Report
  - Synthesis Report
  - Journal papers, animations, fact sheets, training resources, website

- **Capacity development**
  - Mentoring & attachments
  - Technical training
  - Workshops, conferences, symposia
  - Networking & relationship management
New science/new products

- Climate variability, extremes and change in the western tropical Pacific: new science and updated country reports......(BOM & CSIRO, 2014)
- Technical report, country specific chapters:
  - Climate summary
  - Data availability
  - Seasonal cycles
  - Observed trends
  - Climate projections (CMIP5)
- On-line publication
  [http://www.pacificclimatechangescience.org](http://www.pacificclimatechangescience.org)
Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is likely to exceed 2°C for RCP6.0 and RCP8.5, and more likely than not to exceed 2°C for RCP4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Warming will continue to exhibit interannual-to-decadal variability and will not be regionally uniform (see Figures SPM.7 and SPM.8). {11.3, 12.3, 12.4, 14.8}
New science/new products

- **Climate Change in the Pacific: A Regional Summary of New Science and Management Tools (CSIRO, BoM & SPREP, in prep)**
  - Plain language report: “telling the story of the science”...
  - Targeted at non-technical audience in the Pacific, incl:
    - Sectoral policy makers, planners & associated decision-makers
    - National/sub-national to community level
  - Regional context but with PIC perspectives:
    - Understanding changing climate in the Pacific
    - About the science – climate data, modelling, projections & RCPs, uncertainty, confidence, downscaling
    - Large-scale climate features
    - Temperature, rainfall, oceans, tropical cyclones
    - Climate science tools
  - On-line publication ([http://www.pacificclimatechangescience.org](http://www.pacificclimatechangescience.org))
Tools, Communication and Outreach Products

• Existing:
  – Enhanced development of CliDE and data portals
  – >35 peer reviewed journal papers incl. partner country co-authorships (+ PCCSP!!), IPCC AR5 (WG 1 & 2) reporting + misc. other reports and databases
  – Animations:
    • Climate Crab - regional
    • Cloud Nasara - Vanuatu

• New:
  – Pacific Climate Futures V2.0 (n.b. PVUDP)
  – Technical Report:
    • New Science & updated Country Reports

• Pending:
  – Summary Report (for policy makers; non-Technical)
  – Training materials, Fact Sheets & new country brochures (non-Technical)
Data rescue & digitisation

Table 1 - Number of daily records key-entered during this project (to 31 May 2013)

<table>
<thead>
<tr>
<th>Type</th>
<th>Country</th>
<th>Stations</th>
<th>Work Estimate</th>
<th>Work Done</th>
<th>% Done</th>
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<tr>
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<td>daily</td>
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<td>25915</td>
<td>25915</td>
<td>100</td>
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<tr>
<td>daily</td>
<td>Samoa</td>
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<tr>
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<td>19710</td>
<td>6218</td>
<td>32</td>
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<tr>
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<tr>
<td>subdaily</td>
<td>Samoa</td>
<td>52</td>
<td>294555</td>
<td>142954</td>
<td>49</td>
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</tbody>
</table>

Table 2 - Partner PIC trainees in digitising data into CliDE in this project

<table>
<thead>
<tr>
<th>Country</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
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<td>3</td>
<td>4</td>
</tr>
<tr>
<td>East Timor</td>
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<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Kiribati</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Niue</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>PNG</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Samoa</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Tonga</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>32</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>
• CliDE is now installed and training provided to met services in 14 Pacific Island Countries plus East Timor
  - now used operationally for data storage and management
  - Visualisation/applications (CLEWS) through CliDEsc (NIWA).

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**Causes of climate change**

The Earth's climate has changed over the centuries and millennia due to a number of different factors (see Figure 9).

These include:

- Natural changes in the Earth's orbit which may occur over time scales of thousands of years
- Natural changes in the sun which affect the amount of incoming solar radiation
- Natural, large-scale volcanic eruptions which eject large amounts of ash into the atmosphere. The ash may remain in the atmosphere for several months or years reflecting sunlight back into space and resulting in a drop of mean global surface temperature
- Changes in atmospheric chemistry (such as the quantity of greenhouse gases) – both natural and caused by human activities. It is almost certain that most of the changes seen in the past century have been caused by human activities such as burning fossil fuels. We will now concentrate on these changes.

*Figure 9: Factors that lead to changes in the Earth's climate.*
Projections Builder: Results

These results were produced using the Pacific Climate Futures Projections Builder, based on the settings selected by the user. It is important to retain a record of those settings.

Representative Models

To identify the representative models, all models were ranked using a multivariate statistical technique (Koic et al., 2002) to identify the model that is the best fit to the settings selected by the user for the Best and Worst cases.

In addition, where possible, the tool identifies the maximum consensus climate future (i.e. the climate future projected by at least 33% of the models and which comprises at least 10% more models than any other).

<table>
<thead>
<tr>
<th>Case</th>
<th>Representative Model</th>
<th>Consensus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Case</td>
<td>CMIP3 - miroc3_2_hires</td>
<td>Very Low</td>
</tr>
<tr>
<td>Worst Case</td>
<td>CMIP3 - gfdl_cm2_1</td>
<td>Low</td>
</tr>
<tr>
<td>Maximum Consensus</td>
<td>CMIP3 - gfdl_cm2_0</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Table 1: Climate Futures description, consensus rating and representative model for each of the three cases: Best, Worst and Maximum Consensus.

<table>
<thead>
<tr>
<th></th>
<th>SURFACE TEMPERATURE</th>
<th>RAINFALL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANNUAL</td>
<td>ANNUAL</td>
</tr>
<tr>
<td>Best Case</td>
<td>3.23°C</td>
<td>-5.7%</td>
</tr>
<tr>
<td>Worst Case</td>
<td>2.46°C</td>
<td>31.3%</td>
</tr>
<tr>
<td>Maximum Consensus</td>
<td>2.46°C</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Table 2: Projected changes for each of the selected variables and seasons for the three cases described in Table 1.

Using These Projections

In applying these projections to an impact assessment, the results for each case should be used separately, resulting in separate statements of impact for each case.

Important: The projected changes shown in Table 2 are the results from the corresponding climate model as described in Tables 1 and 2. They represent the projected 20-year average change, calculated over the region selected and are calculated relative to the historic reference period 1966 to 2005. The projected changes are influenced concurrently by the long-term climate trend and the decade variability as simulated by the relevant climate model.

Use of these results is subject to the Pacific Climate Futures Terms of Use, as updated from time-to-time, which can be viewed at the website http://pacificclimatefutures.net.

A detailed description of the Climate Futures method can be found in Whetton et al. 2012. The use of the method in an impact assessment is described in detail in Clarke et al. 2011.

REFERENCES


Pacific Climate Futures V2.0

Palau Climate Futures

<table>
<thead>
<tr>
<th>EXPERIMENT</th>
<th>TIME PERIOD</th>
<th>Remove</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1B - medium emissions</td>
<td>2030</td>
<td>remove</td>
</tr>
<tr>
<td>A1B - medium emissions</td>
<td>2055</td>
<td>remove</td>
</tr>
<tr>
<td>A1B - medium emissions</td>
<td>2090</td>
<td>remove</td>
</tr>
</tbody>
</table>

Add another

Refresh

2030 A1B - medium emissions

Surface Temperature

Rainfall

2055 A1B - medium emissions

Surface Temperature

Rainfall

2090 A1B - medium emissions

Surface Temperature

Rainfall

Pacific-Australia Climate Change Science and Adaptation Planning Program
Pacific Climate Futures V2.0

- Marine Projections
New products – Pacific Climate Futures V2.0

What’s new:

– CMIP5 Data
– Downscaled data for all countries (50km resolution)
– Online training: access to Projections Builder (Intermediate capability)
– Projections Builder: guided generation of internally consistent projections data (Best, Worst and Max. Consensus cases) tailored to suit non-complex impact assessments
– Compare Projection module: contextualise results from multiple sources (e.g. Downscaling, CMIP3, CMIP5); display changes over time
– Online access to pre-calculated, high quality sea level, SST and ocean acidification data
– Outputs applied to observed data sets ( CliDE/portal) to generate application-ready climate change data (Advanced capability)

www.pacificclimatechangescience.org
www.pacificclimatefutures.net
Climate animations

- Climate Crab (regional) & Klaod Nasara

- Resource kits
New science/new products

- Climate science-based training module & associated materials, including documented ‘manual’ & ppt presentations:
  - Country specific presentations (14 x PICs + Timor-Leste)
    - Tailored for NMSs
  - Regional Pacific current/future climate
  - Understanding climate projections
  - Understanding climate variability and change
    - Tailored for more general use
  - Ppt presentation templates to facilitate ‘small group’ discussions
    - Tailored for more general use
Fact Sheets

Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

Climate variability and climate change in the western tropical Pacific

Each region of the world has its own unique climate, which is the typical weather the region experiences. Natural cycles cause variations in the climate on timescales of decades, seasons and years. Climate change occurs over much longer timescales as a result of natural processes and human activities.

What is the difference between weather and climate?

Weather refers to atmospheric conditions such as temperature and precipitation, which change on a daily basis. Climate refers to the long-term patterns observed on the Earth’s surface. Weather can be described as the current state of the atmosphere at a particular time and place, while climate is the average state over a longer period of time.

Climate change often refers to climate variability and climate change. Climate variability refers to the natural variation in climate over time, while climate change refers to long-term changes in climate that are caused by human activities.

Climate change affects the temperature, precipitation, and other aspects of the climate in the western tropical Pacific. This region is characterized by high temperatures, high humidity, and strong winds. Climate change is expected to affect this region in a number of ways, including:

• Changes in temperature and precipitation patterns
• Changes in the intensity and frequency of extreme weather events
• Changes in the distribution of marine life
• Changes in the availability of freshwater resources

What are the impacts of climate change on the western tropical Pacific?

Climate change is expected to have a number of impacts on the western tropical Pacific, including:

• Changes in the distribution of marine life
• Changes in the availability of freshwater resources
• Changes in the intensity and frequency of extreme weather events
• Changes in the distribution of vegetation

How do we know the climate is changing?

Climate change is a global issue, and there are a number of ways to measure how the climate is changing. These include:

• Measuring changes in temperature
• Measuring changes in precipitation
• Measuring changes in sea level
• Measuring changes in atmospheric composition

Climate change is a complex issue, and it is important to consider a range of factors when making decisions about how to respond to it.

What can we do to adapt to climate change?

There are a number of ways to adapt to climate change, including:

• Building resilience to extreme events
• Reducing vulnerability to climate change
• Developing new technologies
• Protecting ecosystems

It is important to consider a range of factors when making decisions about how to adapt to climate change.

Fact Sheets (http://www.pacificclimatechangescience.org):

• Climate variability & change
• Large-scale climate processes
• Climate extremes
• Sea-level rise
• Ocean acidification

Pacific-Ocean Climate Change Science and Adaptation Planning Program (PACCSAP)

Large-scale features in the western tropical Pacific

The Pacific Ocean covers three-quarters of the Earth’s surface and is one of the largest and most important bodies of water on the planet. It is a vast expanse of interconnected ocean basins, separated by islands and coral reefs. The Pacific Ocean is home to a diverse range of marine life, including many species of fish, coral, and other marine plants and animals.

The Pacific Ocean is also a major source of fresh water, as it is the largest body of water on the planet and contains a vast amount of water. This water is vital for the health of the planet, as it helps to regulate the Earth’s climate and provides a home for a wide range of species.

The Pacific Ocean is also an important source of food, as it is home to a wide range of species that are used as food by humans. These species include fish, shellfish, and other marine animals.

The Pacific Ocean is also a major source of energy, as it is home to a large number of oil and gas fields, as well as many other resources.

The Pacific Ocean is also an important source of recreation, as it is home to a wide range of activities, including sailing, diving, and fisherman.

The Pacific Ocean is also an important source of tourism, as it is home to a wide range of destinations, including islands, coral reefs, and other natural wonders.

The Pacific Ocean is also an important source of jobs, as it is home to a wide range of industries, including fishing, shipping, and tourism.

The Pacific Ocean is also an important source of income, as it is home to a wide range of industries, including fishing, shipping, and tourism.

The Pacific Ocean is also an important source of inspiration, as it is home to a wide range of natural wonders, including islands, coral reefs, and other natural wonders.
Vanuatu: Temperature Projections

Historical and Simulated Mean annual Surface Air Temperature – Vanuatu

Temperature anomaly relative to 1986–2005 (Celsius)

Year

Australian Government
Vanuatu: Rainfall Projections

Historical and Simulated Mean annual Precipitation – Vanuatu

Precipitation anomaly relative to 1986-2005 (%)

Year

1980 2000 2020 2040 2060 2080

Pacific-Australia Climate Change Science and Adaptation Planning Program

Australian Government
Vanuatu: Sea Level Projections

Graph showing sea level projections for Vanuatu with different scenarios and data sources.

Projections:
- RCP8.5
- RCP6.0
- RCP4.5
- RCP2.6

Data sources:
- Reconstruction
- Satellite altimeter
- Tide gauges (3)

Sea level relative to 1966-2005 (cm) over the years from 1950 to 2100.

Map showing Pacific-Australia Climate Change with variable temperatures and pressure patterns.
Wave climate description in the historical-current context is developed from a hindcast made by forcing a wave model with reanalysis winds (left), while projected changes are made by forcing the wave model with CMIP5 model winds and looking at the change in wave properties between historical and future time slices (right).

Mean annual cycle of wave height (blue) and mean wave direction (green) at Rarotonga in hindcast data.

Region of validated high-resolution 30-year wave hindcast, showing a global 0.4 degree grid, with a series of nested grids of 10 and 4 arcminutes (~18 & 7 km respectively) in the western tropical Pacific.
Vanuatu: Marine Projections

Projected decreases in aragonite saturation state for Vanuatu

- Observations
- RCP 2.6
- RCP 4.5
- RCP 8.5

Year:
- 2000
- 2020
- 2040
- 2060
- 2080
- 2100
Vanuatu: Marine Projections

Table 16.5: Projected changes in severe coral bleaching risk for the Vanuatu EEZ for increases in SST relative to 1982–1999.

<table>
<thead>
<tr>
<th>Temperature change (^1)</th>
<th>Recurrence interval (^2)</th>
<th>Duration of the risk event (^3)</th>
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</thead>
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<tr>
<td>Change in observed mean</td>
<td></td>
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<tr>
<td>+0.25°C</td>
<td>26.1 years (24.8 years – 27.4 years)</td>
<td>5.6 weeks (5.1 weeks – 6.0 weeks)</td>
</tr>
<tr>
<td>+0.5°C</td>
<td>20.3 years (15.8 years – 24.4 years)</td>
<td>5.3 weeks (4.2 weeks – 6.5 weeks)</td>
</tr>
<tr>
<td>+0.75°C</td>
<td>9.5 years (3.2 years – 18.0 years)</td>
<td>6.9 weeks (3.3 weeks – 2.3 months)</td>
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<tr>
<td>+1°C</td>
<td>3.1 years (7.4 months – 8.7 years)</td>
<td>8.0 weeks (2.2 weeks – 3.5 months)</td>
</tr>
<tr>
<td>+1.5°C</td>
<td>11.8 months (4.9 months – 3.2 years)</td>
<td>3.1 months (2.8 weeks – 5.3 months)</td>
</tr>
<tr>
<td>+2°C</td>
<td>8.0 months (5.0 months – 1.6 years)</td>
<td>4.8 months (1.7 months – 6.5 months)</td>
</tr>
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</table>
## Vanuatu: Projections Summary

<table>
<thead>
<tr>
<th>Variable</th>
<th>Season</th>
<th>2030</th>
<th>2050</th>
<th>2070</th>
<th>2090</th>
<th>Confidence (magnitude of change)</th>
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<tbody>
<tr>
<td>Surface air temperature (°C)</td>
<td>Annual</td>
<td>0.6 (0.4–0.9)</td>
<td>0.7 (0.5–1.1)</td>
<td>0.7 (0.4–1.1)</td>
<td>0.7 (0.3–1.2)</td>
<td>Medium</td>
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<td></td>
<td></td>
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<td>0.9 (0.6–1.5)</td>
<td>1.2 (0.7–1.8)</td>
<td>1.3 (0.8–2)</td>
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<tr>
<td></td>
<td></td>
<td>0.6 (0.4–1)</td>
<td>0.9 (0.6–1.3)</td>
<td>1.2 (1.1–1.9)</td>
<td>1.6 (1.2–2.5)</td>
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<tr>
<td></td>
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<td>0.7 (0.5–1)</td>
<td>1.3 (0.8–2)</td>
<td>2 (1.5–2.9)</td>
<td>2.7 (1.9–4)</td>
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</tr>
<tr>
<td>Maximum temperature (°C)</td>
<td>1-in-20 year</td>
<td>0.6 (0.4–0.9)</td>
<td>0.7 (0.2–0.9)</td>
<td>0.7 (0.3–1)</td>
<td>0.7 (0.3–1)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>event</td>
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<td>0.9 (0.5–1.2)</td>
<td>1.2 (0.6–1.6)</td>
<td>1.3 (0.7–2)</td>
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<tr>
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<td>NA (NA-NA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7 (0.3–1)</td>
<td>1.4 (0.7–2)</td>
<td>2.1 (1.4–3.1)</td>
<td>2.9 (1.9–4.2)</td>
<td></td>
</tr>
<tr>
<td>Minimum temperature (°C)</td>
<td>1-in-20 year</td>
<td>0.5 (0.2–0.9)</td>
<td>0.6 (0.2–1)</td>
<td>0.7 (0.1–1)</td>
<td>0.6 (0.1–0.9)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>event</td>
<td>0.6 (0.1–0.8)</td>
<td>1 (0.3–1.2)</td>
<td>1.1 (0.5–1.6)</td>
<td>1.3 (0.7–1.8)</td>
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<tr>
<td></td>
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<td>NA (NA-NA)</td>
<td>NA (NA-NA)</td>
<td>NA (NA-NA)</td>
<td>NA (NA-NA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8 (0.3–1)</td>
<td>1.4 (0.9–1.8)</td>
<td>2.2 (1.6–2.7)</td>
<td>3 (2.1–3.9)</td>
<td></td>
</tr>
<tr>
<td>Total rainfall (%)</td>
<td>Annual</td>
<td>1 (7–9)</td>
<td>1 (6–9)</td>
<td>0 (10–9)</td>
<td>0 (8–7)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 (9–13)</td>
<td>0 (9–6)</td>
<td>1 (9–9)</td>
<td>0 (14–10)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2 (4–13)</td>
<td>2 (8–12)</td>
<td>3 (6–16)</td>
<td>4 (11–19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 (6–6)</td>
<td>0 (12–14)</td>
<td>2 (16–15)</td>
<td>5 (15–34)</td>
<td></td>
</tr>
<tr>
<td>Total rainfall (%)</td>
<td>Nov-Apr</td>
<td>2 (5–13)</td>
<td>2 (6–9)</td>
<td>0 (9–14)</td>
<td>1 (7–13)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 (8–15)</td>
<td>1 (9–9)</td>
<td>2 (8–18)</td>
<td>1 (13–13)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 (5–15)</td>
<td>2 (7–11)</td>
<td>3 (5–16)</td>
<td>3 (11–22)</td>
<td></td>
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<td>1 (6–12)</td>
<td>1 (9–13)</td>
<td>3 (14–17)</td>
<td>5 (13–30)</td>
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</tr>
<tr>
<td>Total rainfall (%)</td>
<td>May-Oct</td>
<td>0 (11–12)</td>
<td>1 (8–13)</td>
<td>-1 (17–9)</td>
<td>-2 (15–10)</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 (12–15)</td>
<td>-1 (13–11)</td>
<td>-2 (14–12)</td>
<td>-1 (25–14)</td>
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<tr>
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<td></td>
<td>2 (6–13)</td>
<td>2 (11–16)</td>
<td>2 (11–18)</td>
<td>5 (9–21)</td>
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</tr>
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<td></td>
<td>-2 (10–8)</td>
<td>-1 (19–16)</td>
<td>-1 (21–17)</td>
<td>3 (26–34)</td>
<td></td>
</tr>
<tr>
<td>Aragonite saturation state (QaS)</td>
<td>Annual</td>
<td>-0.3 (-0.7–0.0)</td>
<td>-0.4 (-0.7–0.1)</td>
<td>-0.4 (-0.7–0.0)</td>
<td>-0.3 (-0.7–0.0)</td>
<td>Medium</td>
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<tr>
<td></td>
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<td>-0.4 (-0.7–0.0)</td>
<td>-0.6 (-0.9–0.3)</td>
<td>-0.7 (-1.0–0.4)</td>
<td>-0.8 (-1.1–0.5)</td>
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<tr>
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<td>NA (NA-NA)</td>
<td>NA (NA-NA)</td>
<td>NA (NA-NA)</td>
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<tr>
<td></td>
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<td>-0.4 (-0.7–0.1)</td>
<td>-0.8 (-1.1–0.5)</td>
<td>-1.2 (-1.4–0.9)</td>
<td>-1.5 (-1.8–1.3)</td>
<td></td>
</tr>
<tr>
<td>Mean sea level (cm)</td>
<td>Annual</td>
<td>13 (8–19)</td>
<td>23 (15–31)</td>
<td>32 (20–45)</td>
<td>42 (25–59)</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 (8–18)</td>
<td>23 (15–32)</td>
<td>36 (23–49)</td>
<td>48 (30–67)</td>
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</tr>
<tr>
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<td>13 (8–18)</td>
<td>23 (15–31)</td>
<td>35 (23–48)</td>
<td>50 (32–89)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 (8–18)</td>
<td>26 (17–35)</td>
<td>43 (29–59)</td>
<td>64 (42–89)</td>
<td></td>
</tr>
</tbody>
</table>

**Pacific-Australia Climate Change Science and Adaptation Planning Program**

**Australian Government**
Post-PACCSAP future

- PACCSAP Science Program finishes in 2014
  - New strategic benchmark in fundamental climate science for the western tropical Pacific (n.b. alignment with IPCC AR5)
  - Evaluation & final reporting: leverage off new knowledge, capacity & key learnings on regional/inter-regional basis

- Strategic considerations:
  - Manage/action existing knowledge & information to ensure sustainable legacy!!
  - Plan for sustainable resilient development
    - Role of climate science/outreach to inform/facilitate evidence-based decision making?
    - GFCS innovation pathway
  - Support in-country capacity development
    - Coordination, collaboration
  - What are the new and emerging regional/inter-regional needs:
    - tailored/application-ready, multiple sectors, multiple risks, multiple time-frame, finer spatial scale, seamlessly interfaced to DSS!!??

GFCS Guidelines for developing a climate service

Framework is based around five components (or pillars) identified as essential for producing and delivering effective climate services:

- **Users**
- **User Interface Platform**
- **Climate Service Information System**
- **Observations and monitoring**
- **Research, Modelling and Prediction**
- **Capacity Development**
Thank you

For further information

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