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Future climate impacts on pearl farming in the Cook Islands:

A sectoral case study for application of Next-Gen projections for the Western Tropical Pacific

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Future Climate impacts on pearl farming in the Cook Islands

- This is a collaborative project by CSIRO/SPREP funded by the Australian Government through the Australia-Pacific Climate Partnership

IMPORTANT:

- While the climate projections information being presented here is targeted to the Cook Islands Black Pearl industry, **trends and messages are broadly relevant to other regions and sectors in the Pacific**

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Cook Islands black pearls

- Over the past 20 - 30 years, the Cook Islands pearl farming industry has become an important aquaculture commodity for the country, and the second largest world supplier of south sea black pearls
- The main pearl farming area in the Cook Islands is in Manihiki Lagoon, a coral atoll situated 1200 kilometres northwest, from Rarotonga

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Cook Islands black pearls

Black-lip pearl oysters, *Pinctada margaritifera* (Linnaeus), and the Cook Islands pearl industry more broadly, is potentially vulnerable to climatic variability and projected changes in climatic conditions:

- changes in sea surface temperature
- changes in water chemistry e.g. calcite and aragonite saturation states
- direct impact from tropical cyclones
- lagoon water quality affected by:
  - Sea level rise
  - Extreme rainfall
- worker comfort
- interactions of the above

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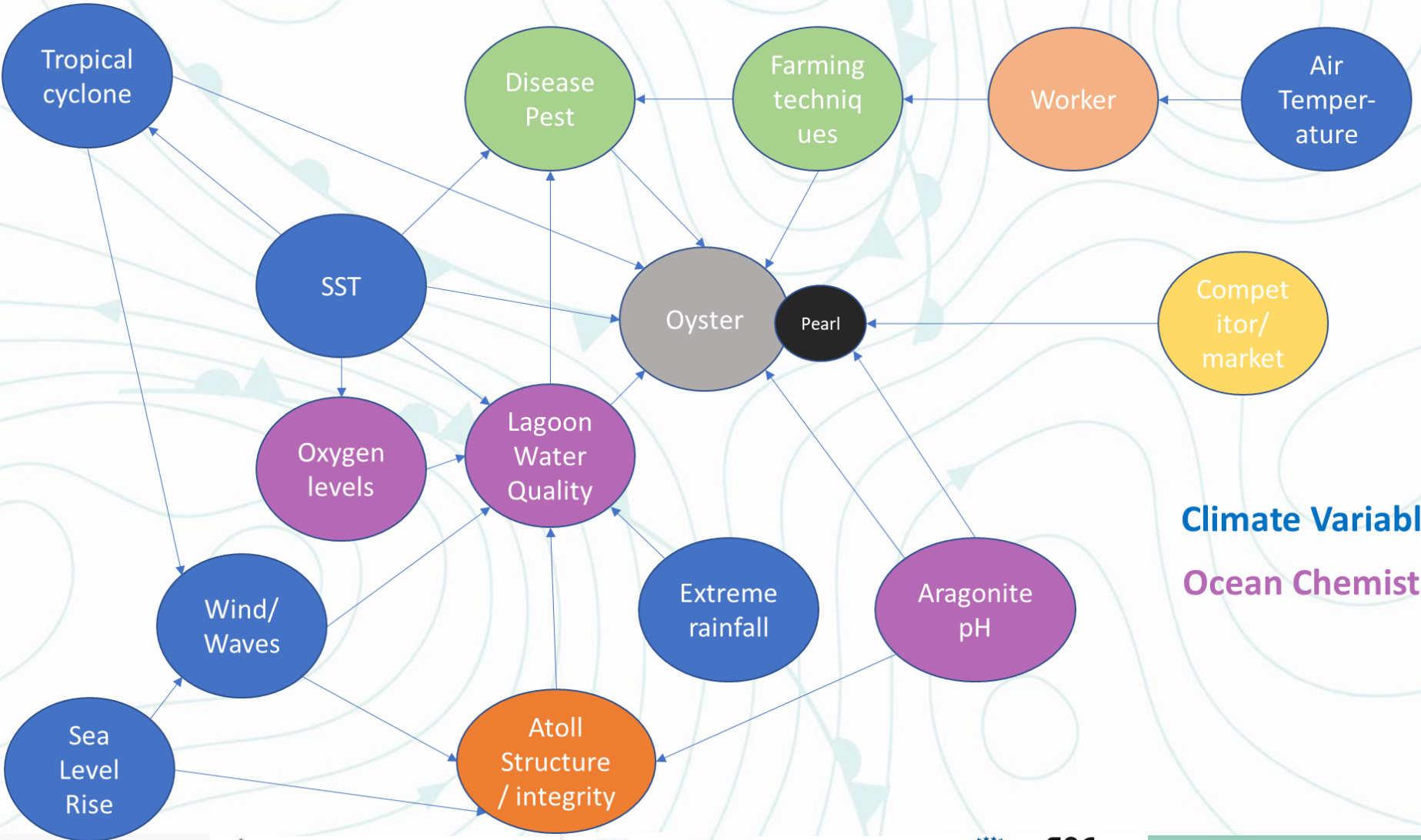
Interaction: Pearl Oyster 'environment'



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NextGen project aims

For Manihiki Lagoon region we explore:

1. Future Sea Surface Temperature (SST) change
2. How Marine Heatwaves (MHW) may change *
3. Projected ocean chemistry changes
4. Updated projections for sea level rise
5. Projected extreme rainfall
6. Regional projections for Tropical Cyclones
7. Future ‘worker comfort’ *

* Not presenting today

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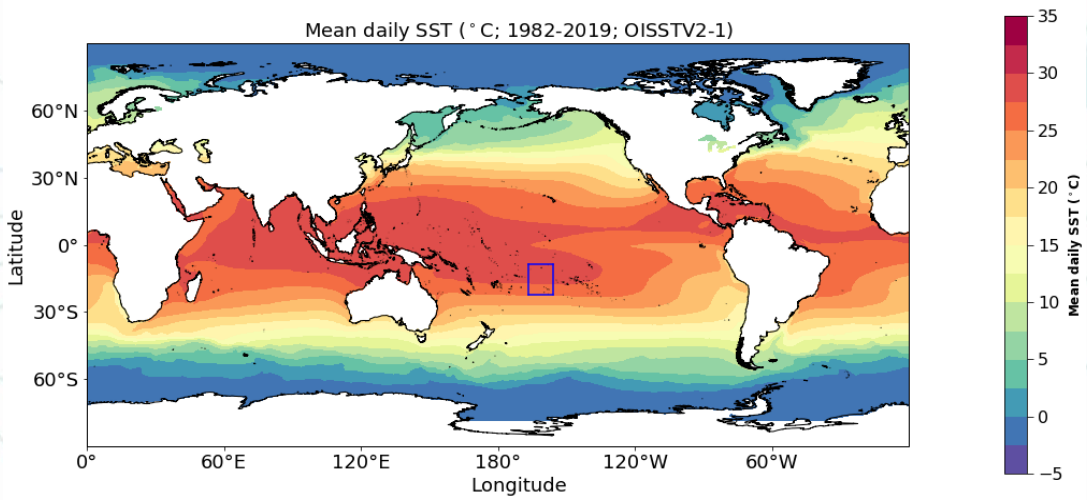
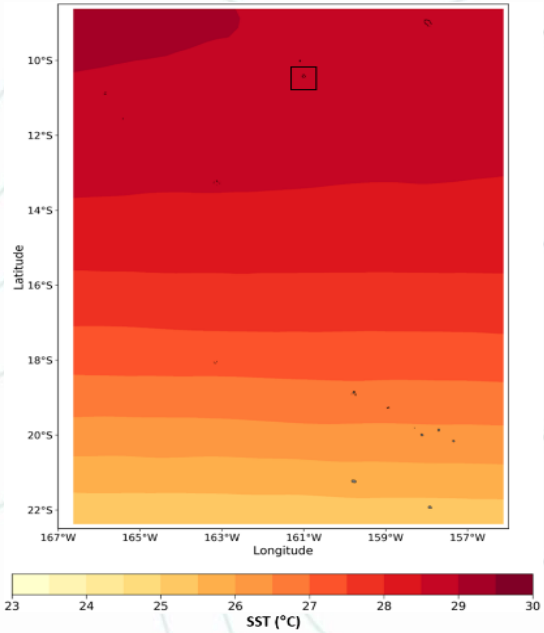
Sea surface temperature: Current climate





NOAA ¼° daily Optimum Interpolation Sea Surface Temperature v2-1 dataset

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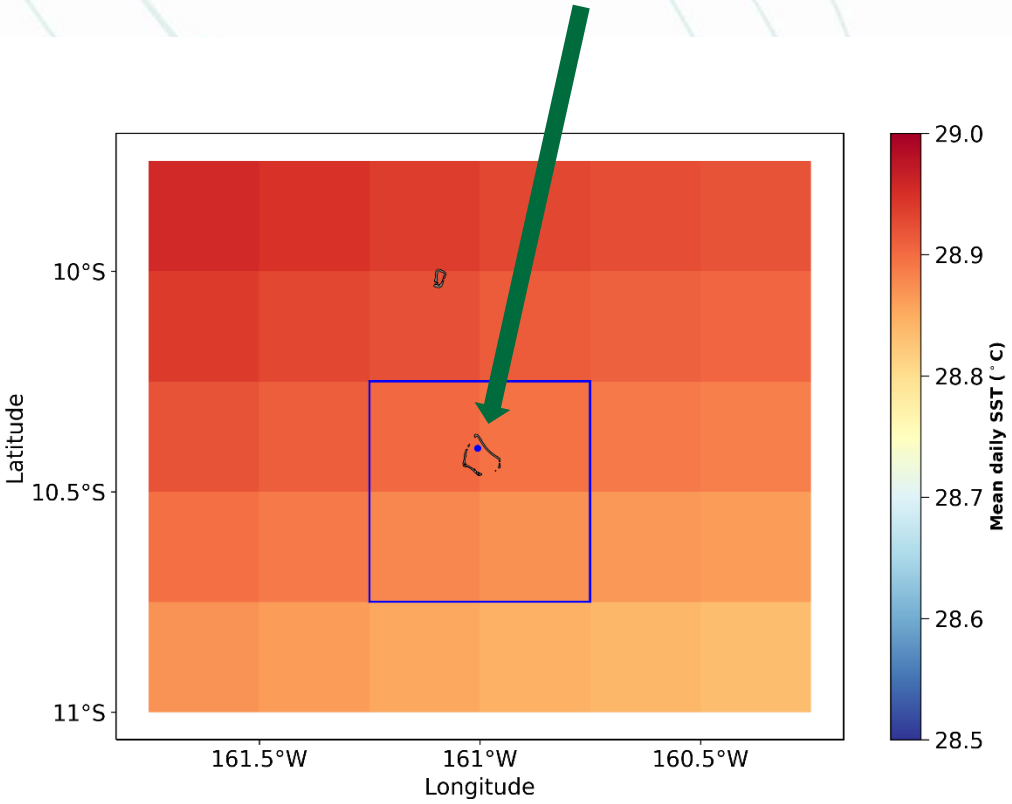
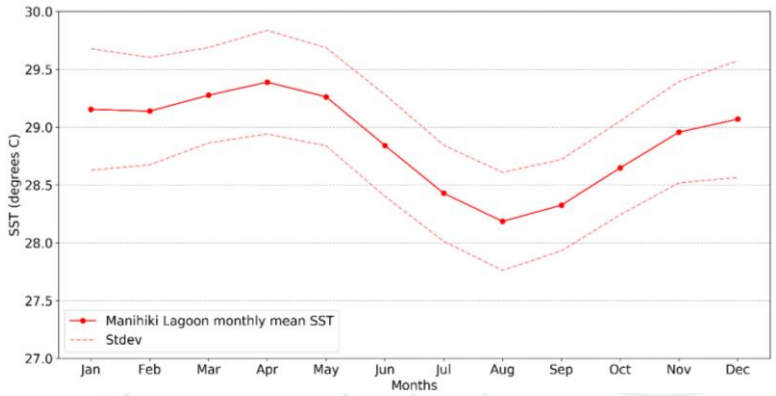
Sea surface temperature: Current climate



NB: Manihiki Lagoon Buoy data will be used to verify global gridded SST data



Mean daily SST (deg C; 1982-2019) for Manihiki Lagoon and surrounding region (OISSTv2-1). Blue circle denotes the location of the Manihiki Lagoon monitoring buoy, and blue square denotes the domain used in area-averaged marine heatwave analyses below.

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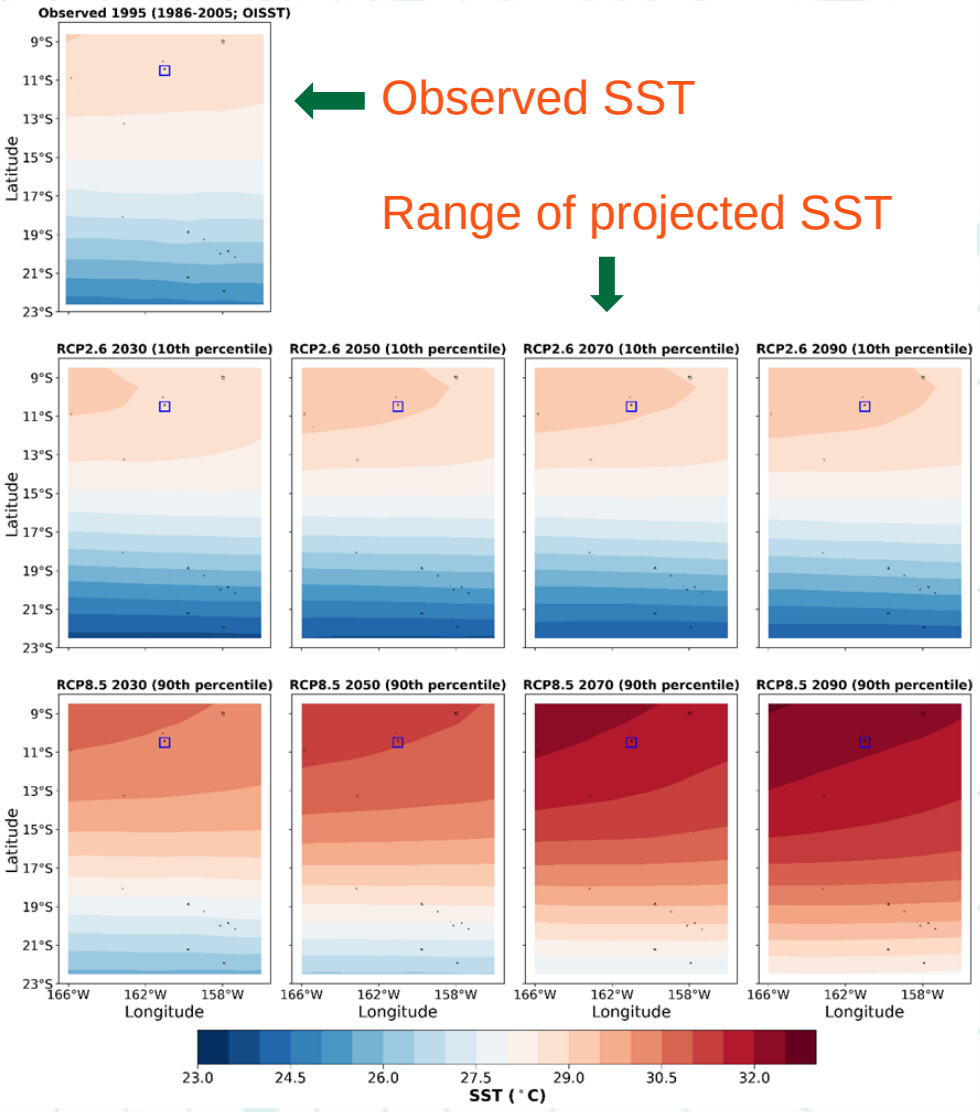
Critical thresholds from literature vary:

- Dynamic Energy Budget model indicates threshold of **34.5 deg C** (Sangare et al. 2020).
- Le Moullac et al. (2016) modelled thermal optimum for:
  - Biomineralization: **21.5-26.5 deg C**
  - Somatic growth and reproduction: **28.7 deg C**
  - Non-lethal thermal-maximum, at **34 deg C**



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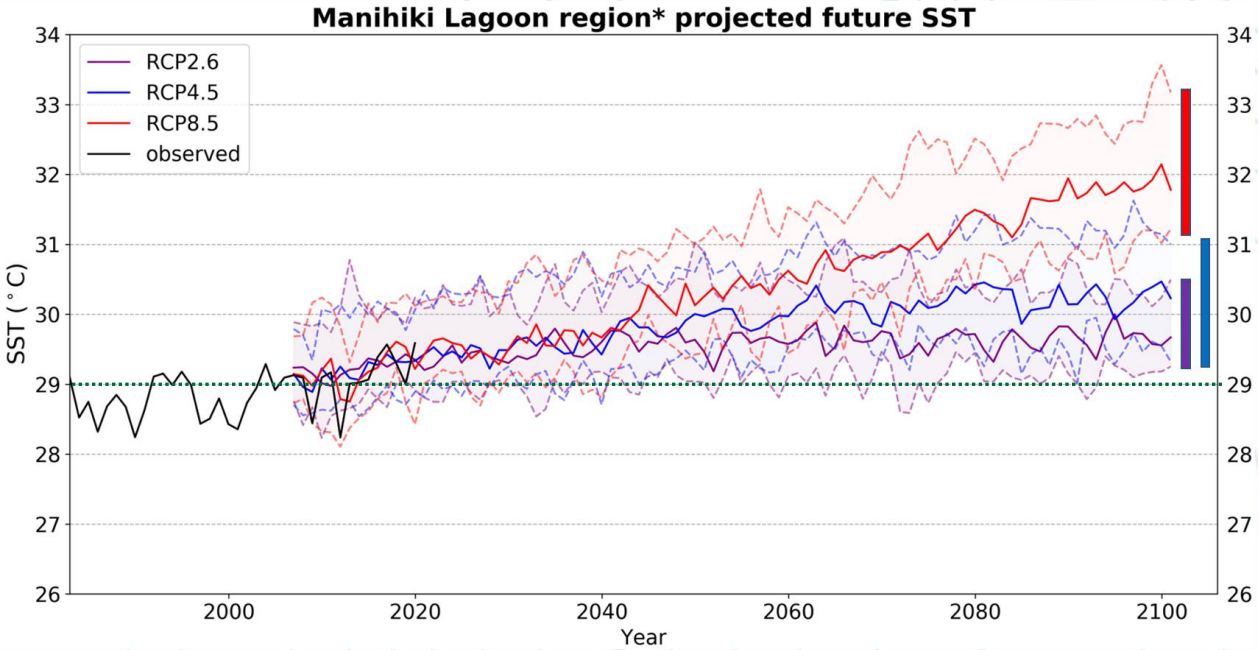
Sea surface temperature: Future climate



High emissions

Lower emissions

* Region encompassing Manihiki Lagoon location, but not specifically for lagoon

- Farmers tend to stop seeding operation when water temperature is above 29 degrees (Ian Bertram pers comm.)

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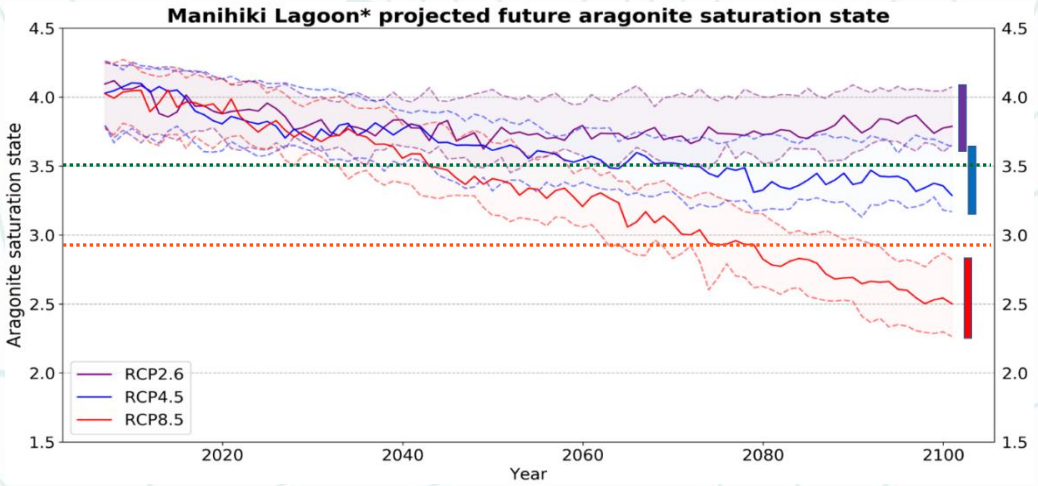
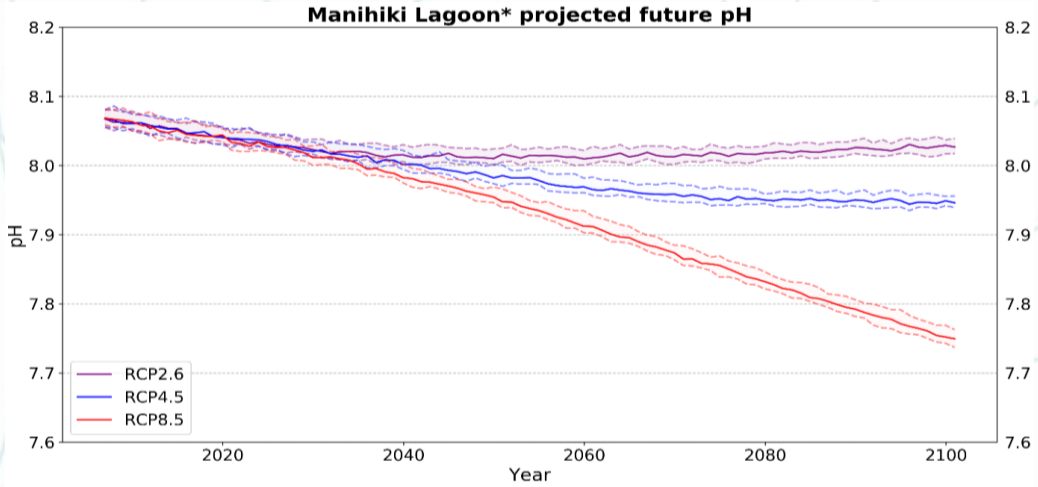
Ocean Chemistry Projections

- **Corals and coral reefs negatively impacted by ocean chemistry changes**
  - marginal conditions indicated at values of 3.5
  - coral reefs have not historically been found (< 3.0)





- **Reduced shell strength and structural integrity at pH 7.8 and 7.6.**
- **Reduced shell deposition rates at pH 7.4.**
- **Further investigations required on the response of juveniles, food, and predators to acidification**

- **Acknowledge Andrew Lenton**

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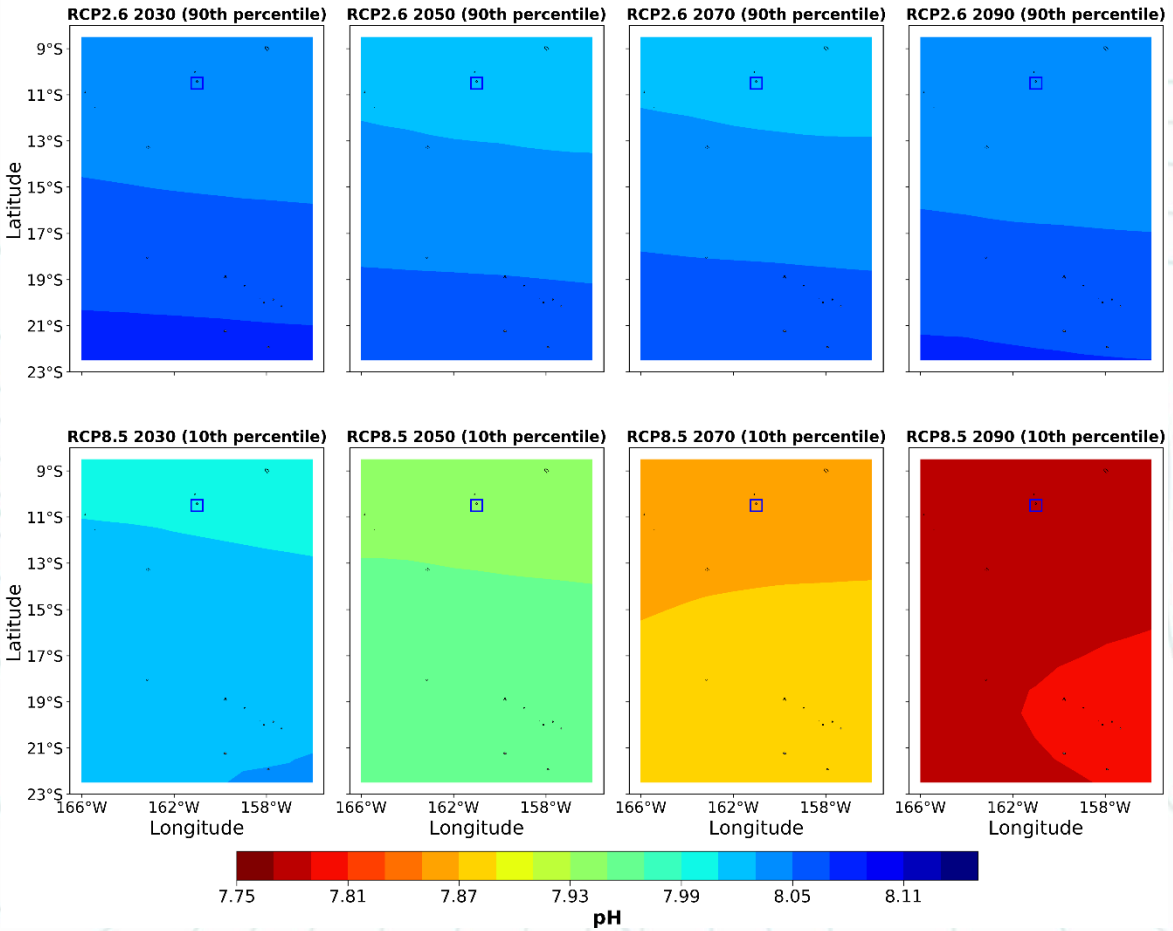
pH projections for the Cook Islands

Lower Emissions pathway

Higher Emissions pathway



Emissions pathways make a difference!

- **Reduced shell strength and structural integrity at pH 7.8 and 7.6.**
- **Reduced shell deposition rates at pH 7.4.**
- **Further investigations required on the response of juveniles, food, and predators to acidification**

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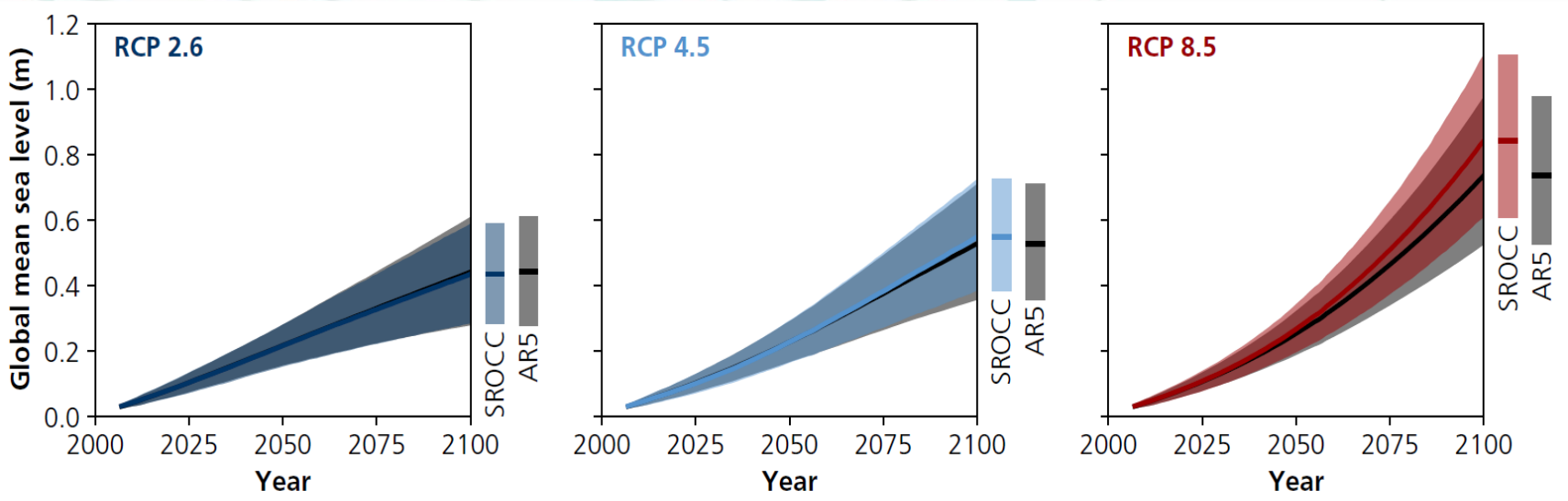
Projected sea level rise

Figure 35. Newly formed sand banks between some *motu* (islets) in Manihiki on the southern exposure are reducing ocean and lagoon water exchange in the area. To the right of the sand bank is the reef flat on the ocean side, and to the left is the lagoon.



SROCC Global Mean Sea Level (2019) updated since the IPCC 5th Assessment Report (AR5) results.

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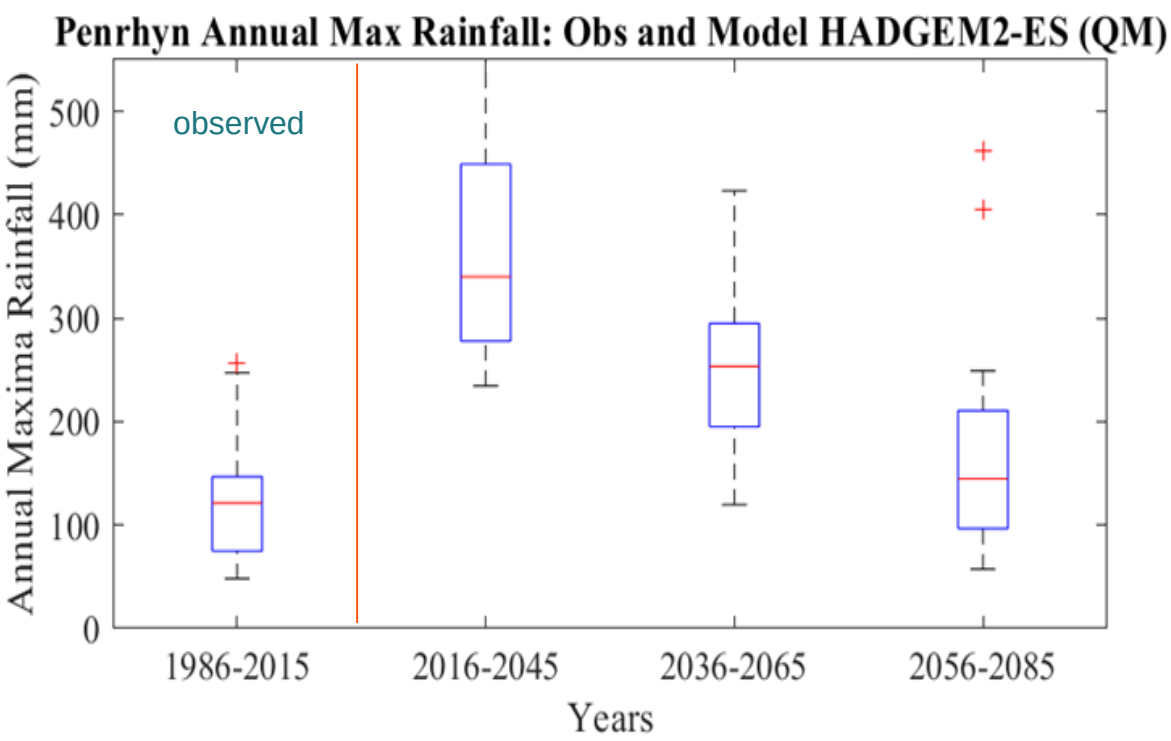
Extreme rainfall: Penrhyn, CI



Observed (1986 – 2015) and projected annual maximum daily rainfall

Acknowledge Anil Deo, Federation Uni

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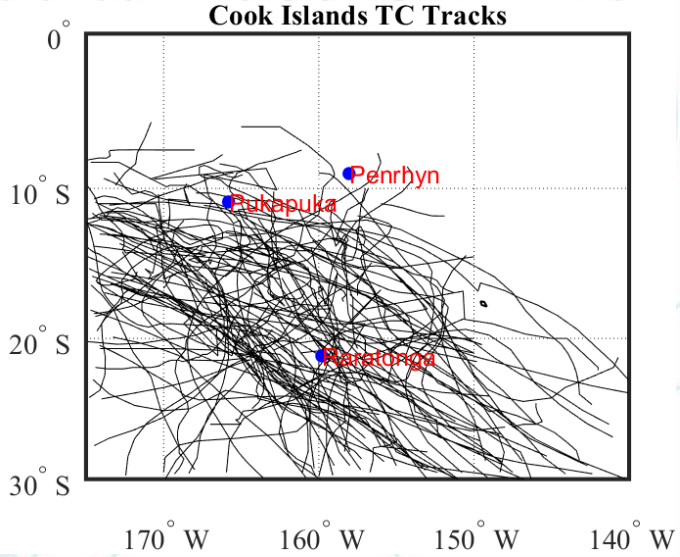
Tropical Cyclones

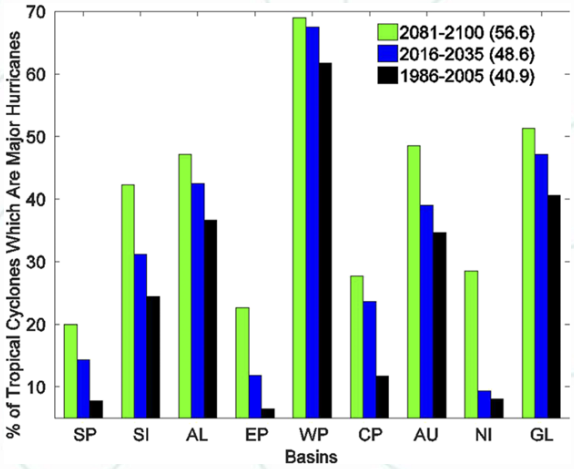
- In the Cook Islands, the projection is for a **decrease** in cyclone genesis (formation) frequency for the South-east basin.

- However, there is a growing consensus that that the strongest cyclones are likely to occur more frequently

- Acknowledge Savin Chand, Federation Uni.



Generalized tracks of 100 cyclones in the Cook Islands, for the period 1970-2019*



*Southwest Pacific Enhanced Archive of Tropical Cyclones (SPEArTC) database (Diamond et al. 2012)

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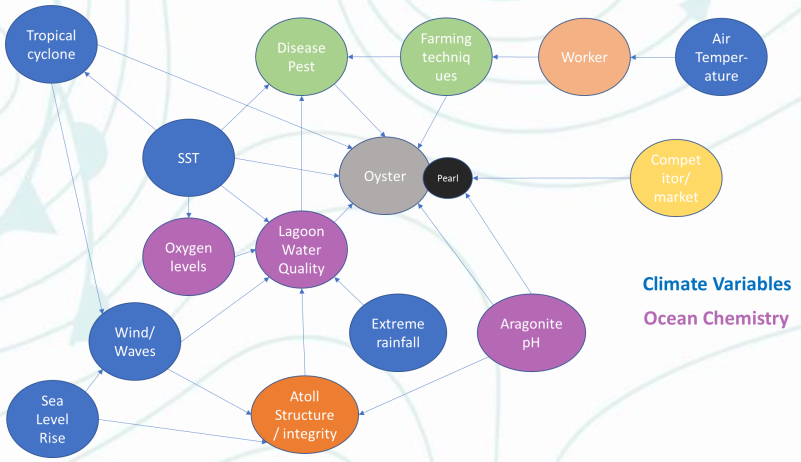
Projected climate change impacts on the Cook Island Black Pearl industry

- Projected changes to the future physical environment is likely to impact:
  - Oyster viability
  - Shell strength and pearl quality
  - Breeding/ spat viability
  - Lagoon water quality
  - Worker comfort
  - TC extreme impact



- Understanding the direction, magnitude and interaction of these changes can help inform adaptation protocols.

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Thank you

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