

# Reconstructing Past Climate Variability from Marshall Islands Corals

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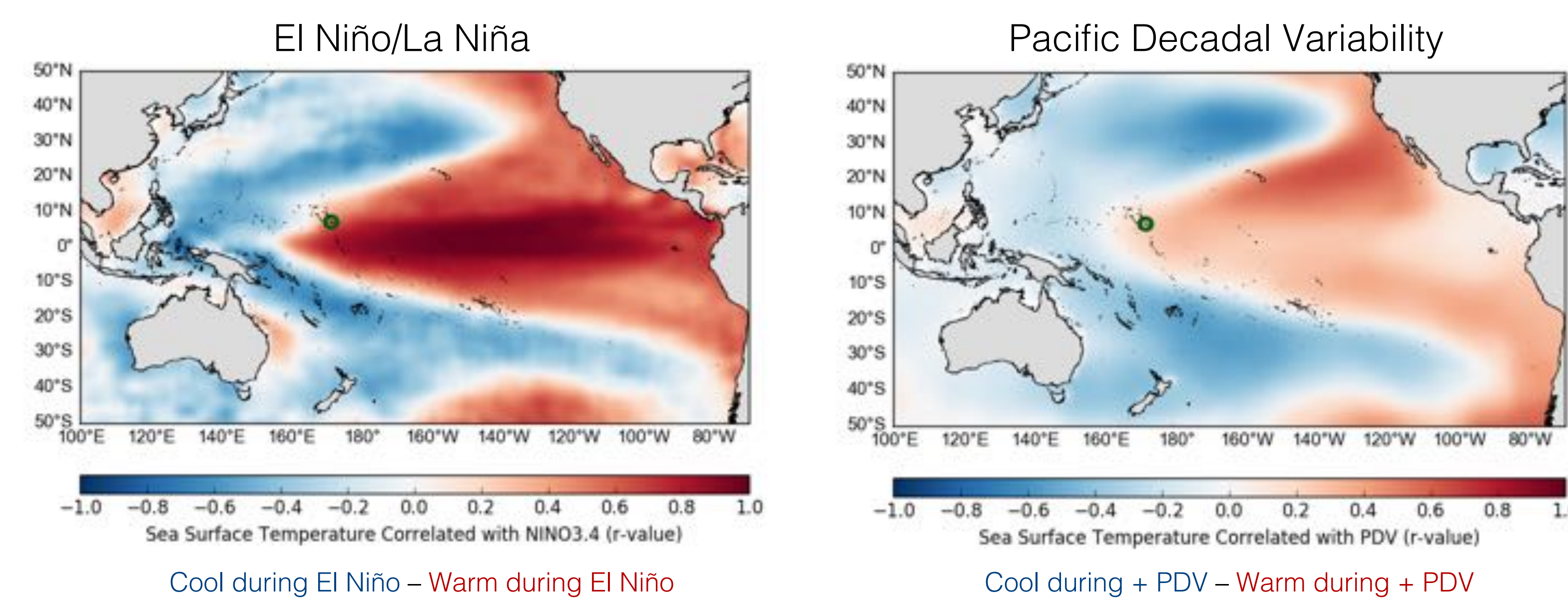


## What is Pacific climate variability?

Changes in Pacific Ocean temperatures are linked to changes in winds, rainfall, and upwelling across the globe.

**El Niño & La Niña:** Patterns of warm/cold water that last ~3 months and occur every 2-7 years

**Pacific Decadal Variability (PDV):** A “slow El Niño”—a pattern of warm or cold water, superimposed on El Niño, that switches every 10-30 years



Above: Maps of relationships between ocean temperatures and El Niño/La Niña (left) and Pacific Decadal Variability (right). Field sites in the Marshall Islands are circled in green (OISSTv2, 1980-2016).

## Why do we care?

Pacific climate variability influences:

- The rate of global climate change<sup>1</sup>
- Drought frequency/intensity<sup>2</sup>
  - For example, the 2015-16 El Niño drought depleted freshwater provisions and led the Marshall Islands to declare a state of emergency
- Ocean temperatures<sup>2</sup>
  - Heat extremes can bleach or kill corals
- The rate of regional sea level rise
  - Marshall Islands are near sea level and flood frequently



Upper left: The Marshall Islands are 2m (~6 ft) above sea level, and are vulnerable to flooding and rising seas. Left: Waves breach a breakwall in Majuro during during king tide. Right: Coral bleaching during the 2015-16 El Niño.

## Key Questions

- How has Marshall Islands ocean temperature varied historically?
- How has Marshall Islands salinity (and rainfall) varied historically?
- How could climate variability influence future sea level rise?
- How does climate variability influence coral health?

Instrumental records are too short to answer these questions (~1950-present). Instead, we use corals, which contain chemical signatures that reflect past climate. By measuring coral geochemistry, we can reconstruct regional climate over the past 100+ years.

## Field Work

Summer 2016:

- Identified large living & fossil corals to core in 2017
- Performed surveys of coral health
- Installed loggers to monitor ocean temperature

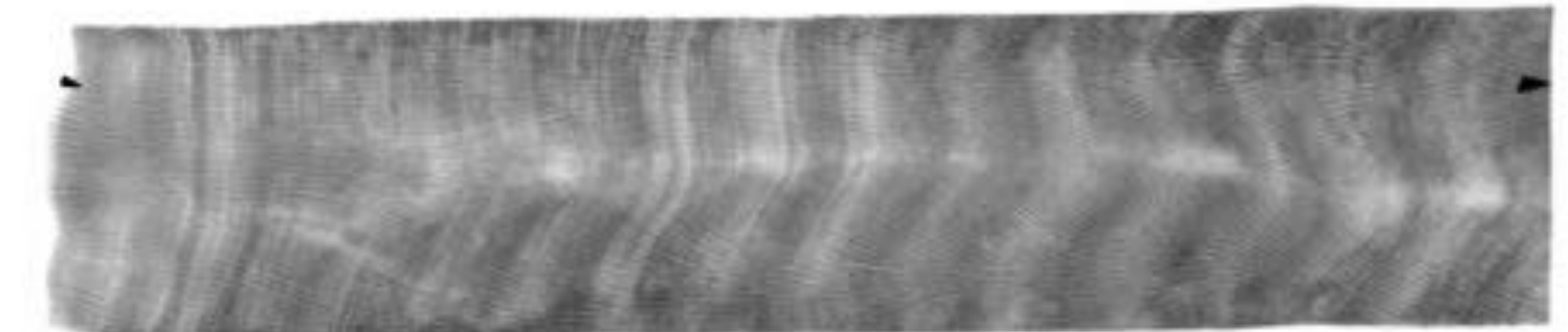
Summer 2017:

- Take cores from priority corals
- Recover temperature loggers



Top: Reef survey sites (blue markers) in Majuro and Arno Atolls (Google Earth). Above left: large *Porites* coral. Right: Performing coral health surveys along a transect line.

## Coral Proxies



X-ray positive of an example *Porites* core from the northern Great Barrier Reef. Each pair of alternating dense (dark) and less dense (light) bands correspond to one year's growth.

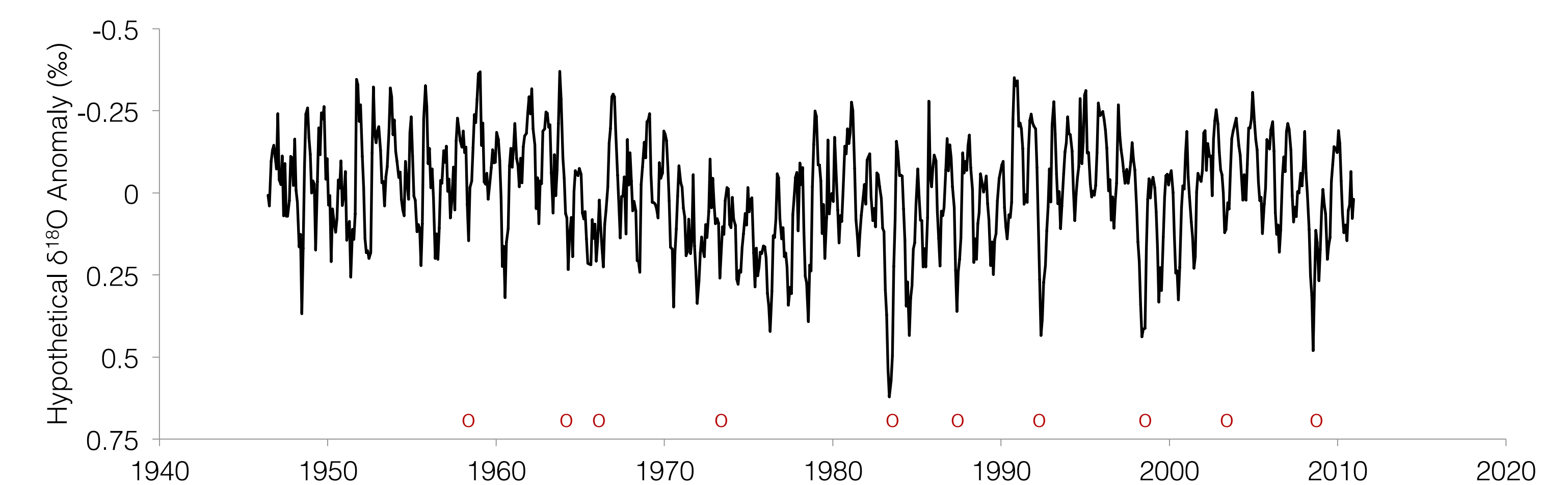
## Geochemistry

- Sr/Ca** Sea surface temperature (SST)<sup>3</sup>
- $\delta^{18}O$**  SST + Salinity<sup>3</sup>
- $\delta^{18}O_{sw}$**  Salinity
- U/Th** Age (fossil corals)

## Growth Banding

- Density, Extension, Calcification**
- Coral growth rate<sup>4</sup>

## How will we use these coral records?



Above: A hypothetical Marshall Islands  $\delta^{18}O_{coral}$  record (modeled with SODA, HadISST). Low values (top of graph) denote warmer and/or fresher water. Red circles correspond to moderate/strong El Niño events.

- Track variation and/or trends in rainfall and temperature
- Identify relationships with Pacific climate variability
- Improve sea level rise predictions (associated with warming and Pacific climate variability)

## The Bottom Line

- Coral geochemistry can record changes in climate over 100+ years
- We can reconstruct Pacific climate variability, which occurs too slowly to capture in short instrumental records
- We can use past climate to anticipate future trends.
- Stay tuned!

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