



Water, Climate, and Local Governance:

Experience from the Pacific Islands

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Aloha



Objectives

- (I) We synthesize the current operational climate forecasts, warning, and response activities of the ‘Pacific ENSO Applications Climate Center’ for hazards management in Hawaii/Pacific Islands; &**
- (II) Discuss the importance of El Niño/La Niña-Southern Oscillation (ENSO)-based climate information products for enhancing the water governance capacity to address disasters.**

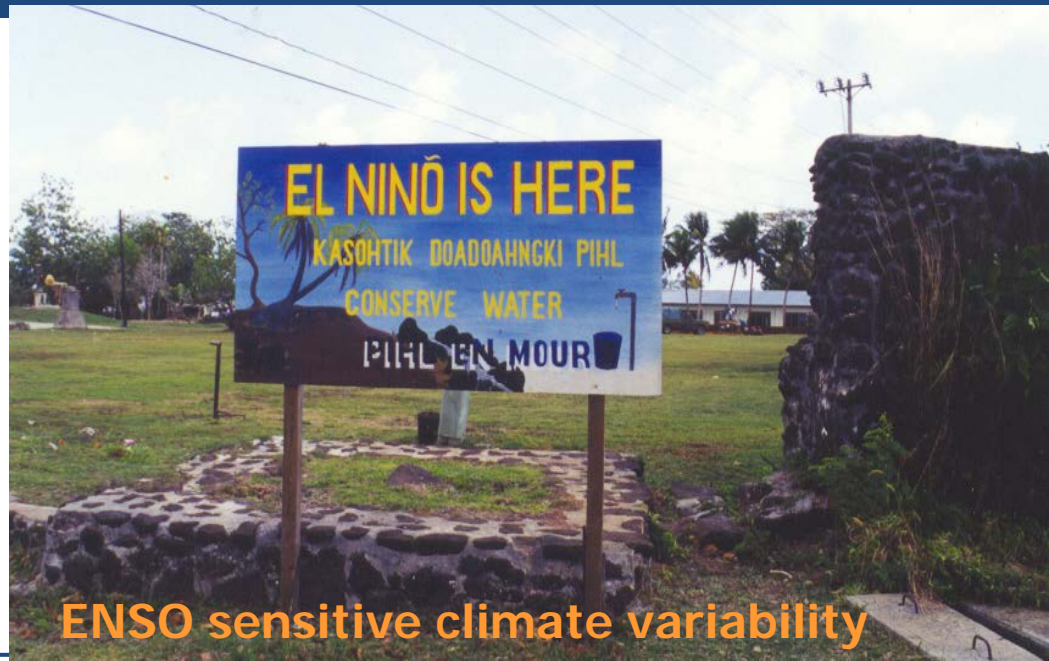
Background: Demand for Customized Climate Services



Climate Counts in the Pacific!!

- I. In 1990, the Government in the USAPI region expressed concern about their vulnerability to climate variability;
- I. Expressed their need for customized climate services—
 - I. tailored understandable technical information and products for climate sensitive sectors (i.e. water resources, agriculture, health.....).

PEAC's Research/Applications: Snapshot



ENSO sensitive climate variability

- I. The spatial resolution of large-scale climate models are too coarse to apply to these islands directly;
- II. The climate variability/change in the Pacific Islands are highly sensitive to ENSO;
- III. So, ENSO and the output of the large-scale models are used to develop statistical model for climate forecasts on seasonal time-scales.

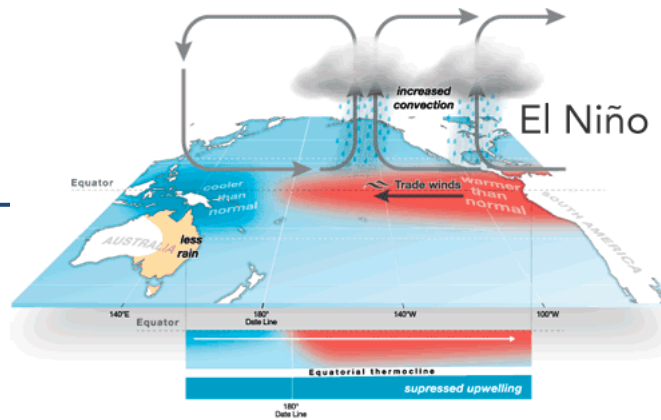
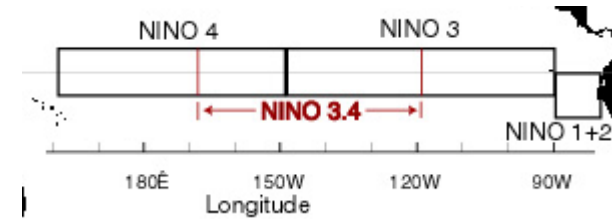
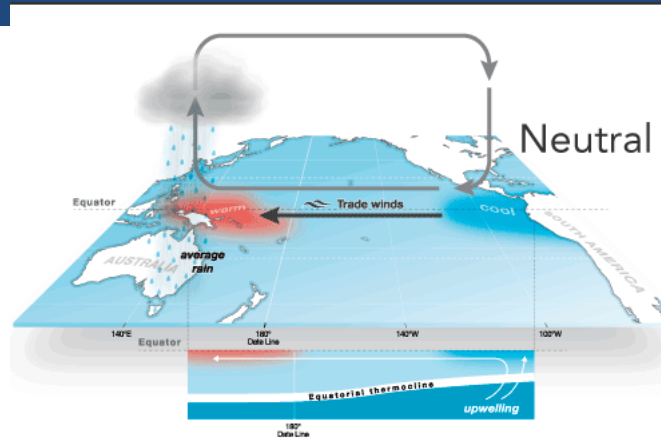
The World



El Niño in a nutshell

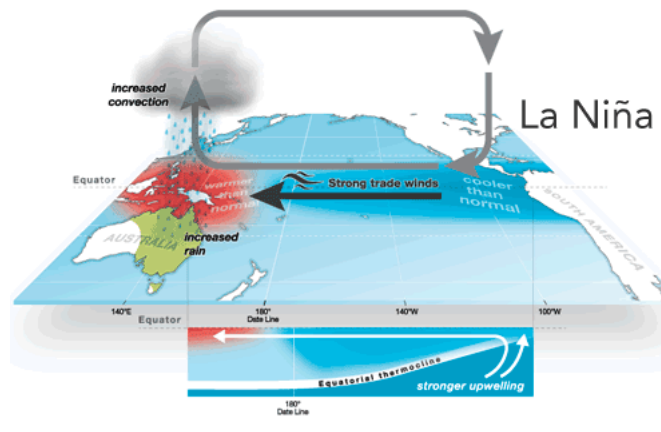
Neutral Conditions:

- Cold sea surface temperatures to the east and warm to the west
- Strong trade winds blowing from east to west
- Rainfall over the Western Pacific



El Niño Conditions:

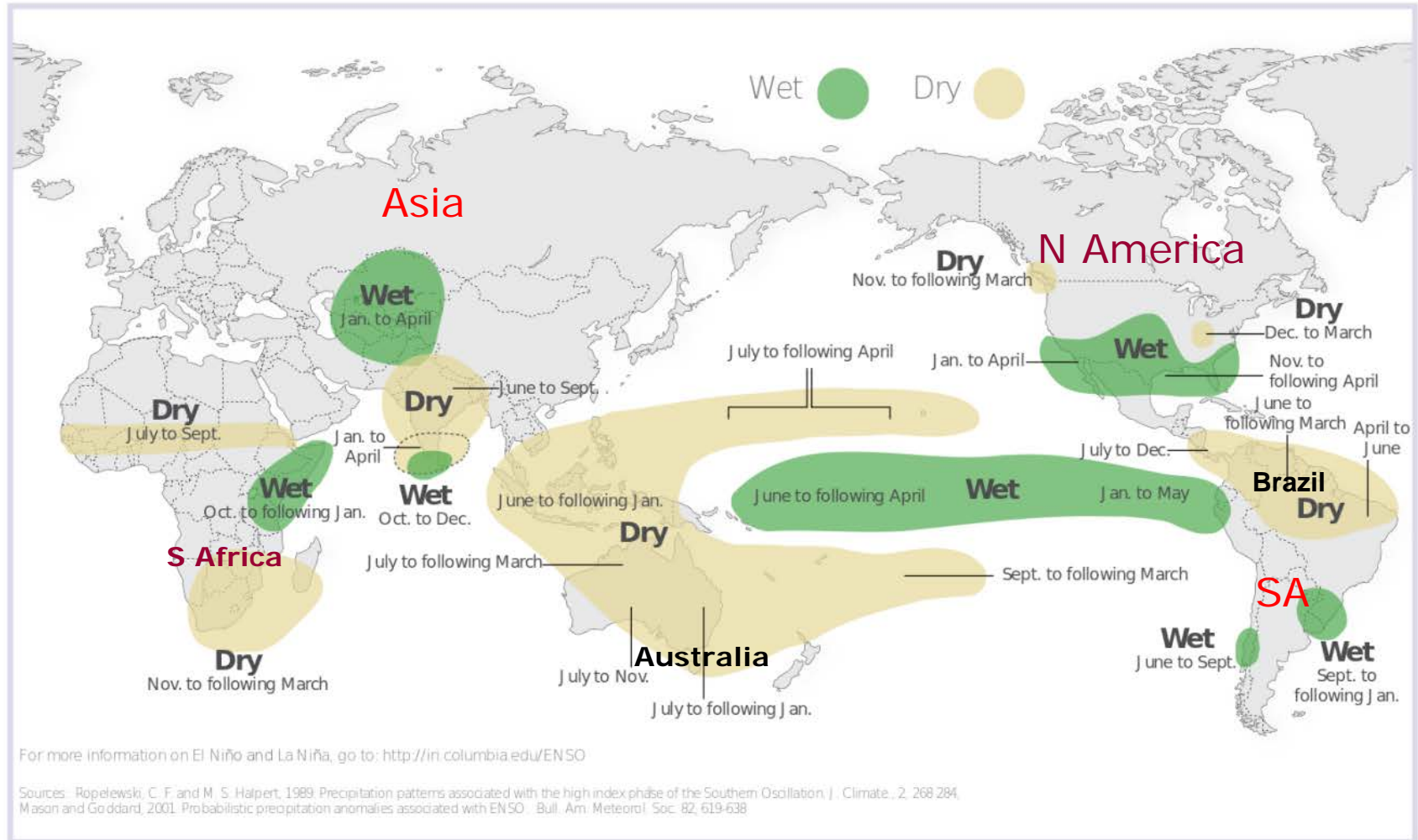
- Warm sea surface temperatures to the east and cold to the west
- Weakened trade winds, westerly winds over east Pacific
- Rainfall over the Central and East Pacific



La Niña occurs as an enhanced version of the neutral state.

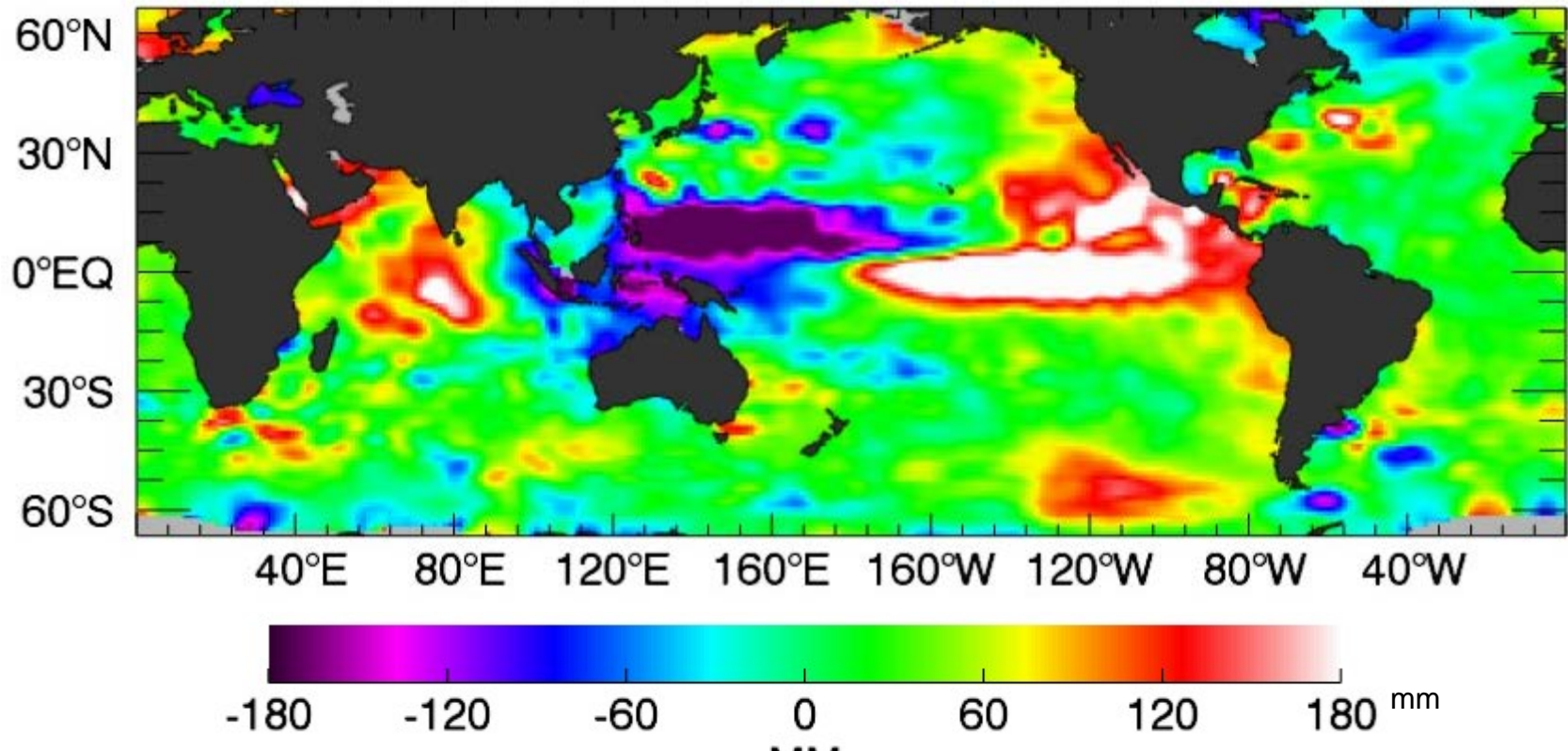
El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



Sea Level Observation

Jason-2 Sea Level Residuals OCT 31 2015

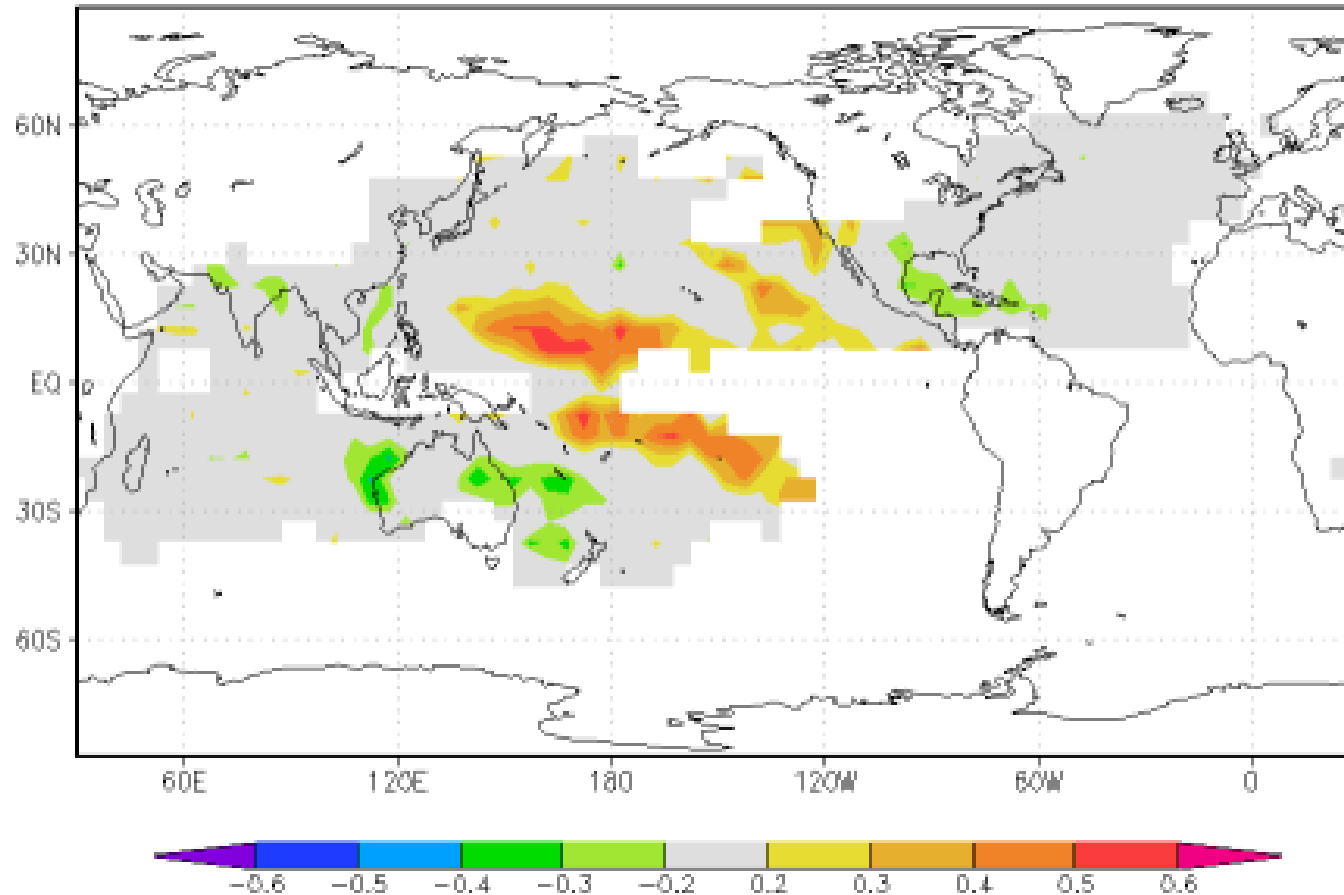


Sea Levels have been

- Below average over Western Pacific Basin
- Above average over the Central and Eastern Pacific

El Niño and Tropical Cyclones

corr Jul–Jun averaged NINO3.4 index
with Jul–Jun averaged MIT #TS tracks 1856:2004



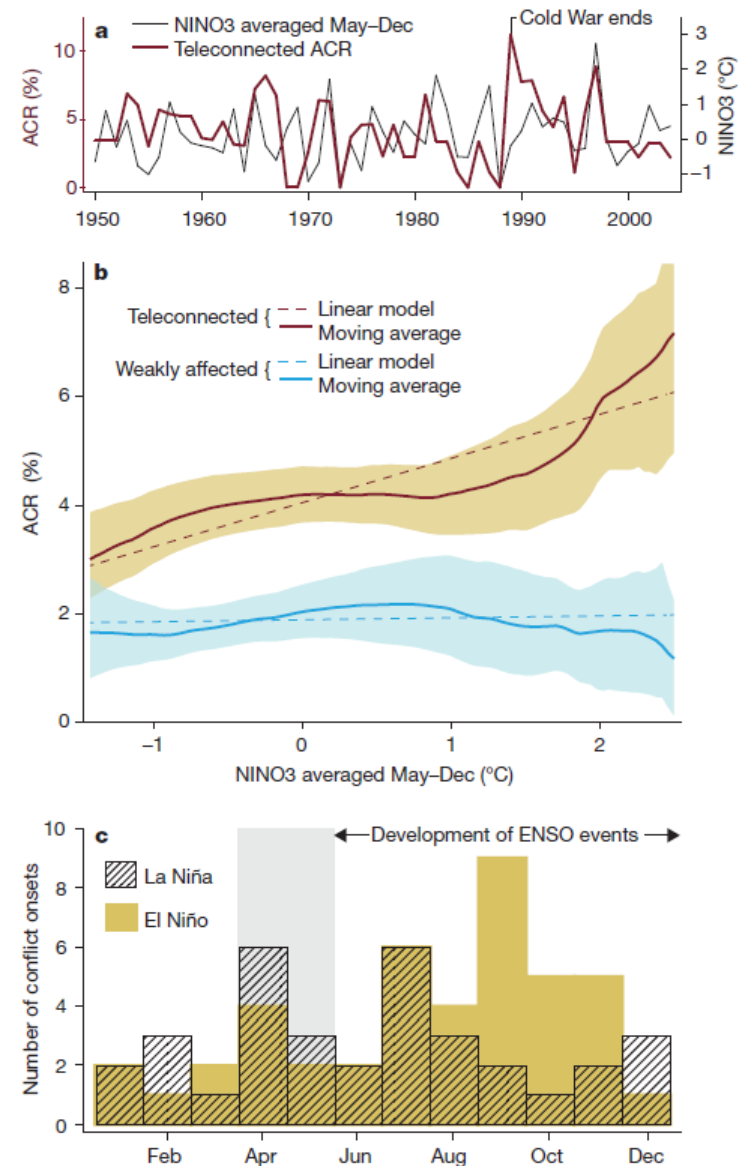
El Niño shifts TC genesis Eastward over the North and South Western Pacific

- Less TC activity
 - Australia
 - Philippines
- More TC activity
 - Tropical Pacific
 - Hawaii
 - American Samoa

Conflict risk associated with ENSO

Drought is widely believed to relate to conflict!

- a) Time series of NINO 3 and Annual Conflict Risk (ACR) for the teleconnected group
- b) Linear and non-parametric fit of ACR against NINO 3
- c) Number of conflict onsets in teleconnected countries during
 - El Niño, solid bars
 - La Niña, hatched bars



Impacts of ENSO: USAPI

1997-1998 El Niño



- Low rainfall/low sea level
- Water rationing in Majuro
- Crop losses in F.S. of Micronesia, R. Marshall Islands, C.N. Mariana Islands
- Palau experienced 9-month drought

2007-2008 La Niña

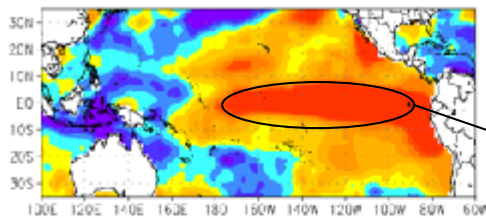


- Damage of roads and infrastructures
- Impacts on agriculture /aquaculture through inundations; decline in soil quality
- Changes in surface/groundwater quality

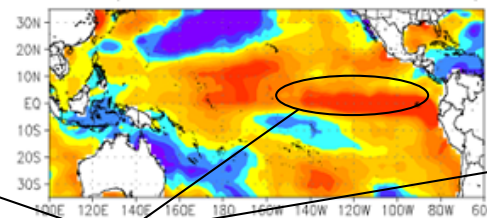
SST Composites for low and high sea level years—

Guam

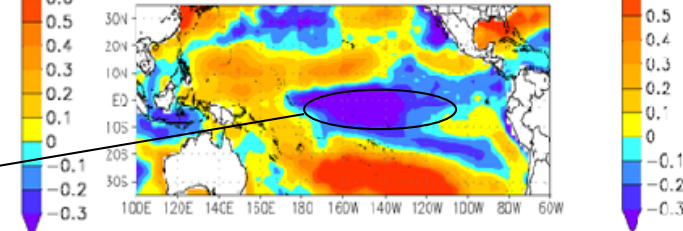
SST average (JAS): LSL years
1967, 72, 74, 82, and 97



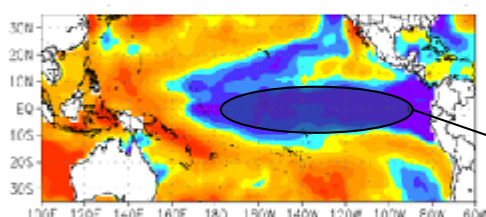
SST average (AMJ): LSL years
1967, 72, 74, 82, and 97



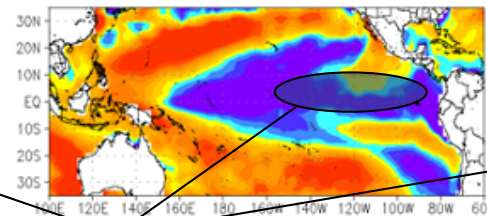
SST average (JFM): LSL years
1967, 72, 74, 82, and 97



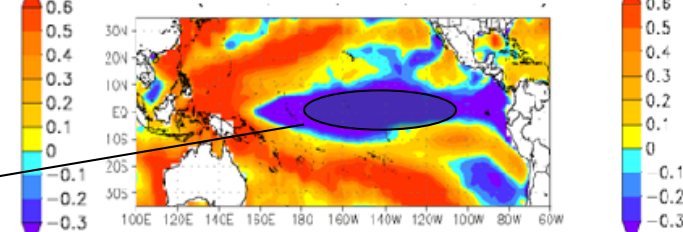
SST average (JAS): HSL years
1971, 84, 96, 99, and 00



SST average (AMJ): HSL years
1971, 84, 96, 99, and 00

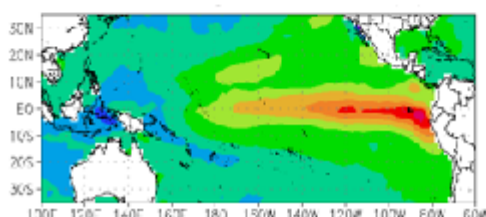


SST average (JFM): HSL years
1971, 84, 96, 99, and 00

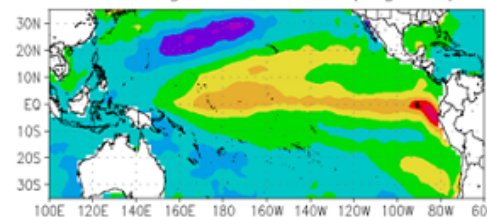


El Niño signal

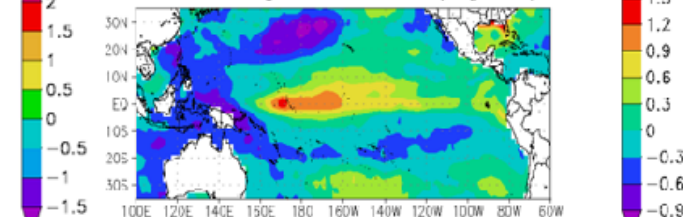
SST difference (JAS): Low-High



La Niña signal
SST difference (AMJ): Low-High



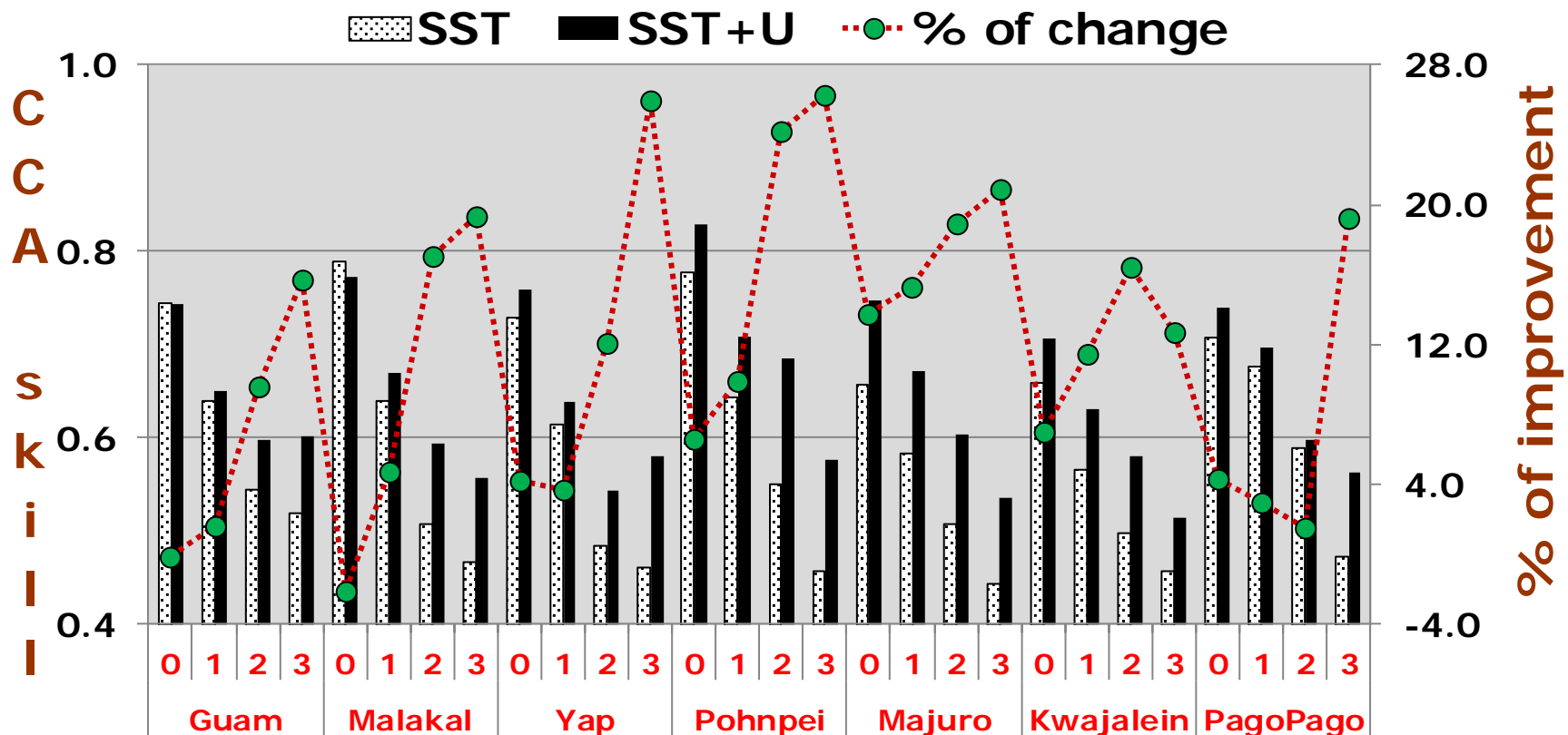
SST difference (JFM): Low-High



Probabilistic forecasts for sea level variability is possible well ahead of time....

Sea-level forecasts

CCA cross-validation skill



- CCA allows us to identify pairs of patterns of two multivariate data sets and construct transformed variables by projecting the original data onto these patterns (X: SST or SST-U; Y: SL)

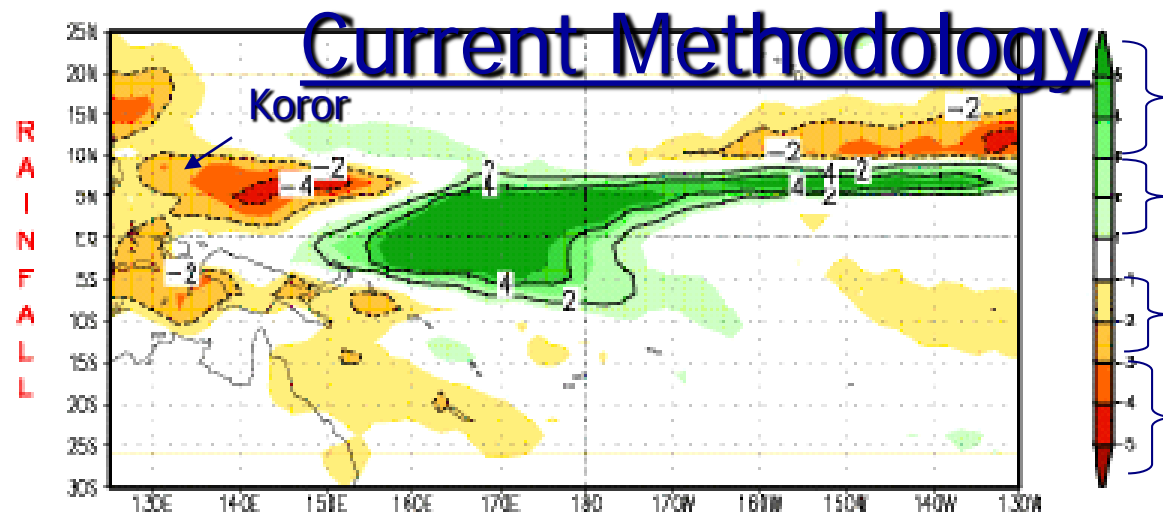
Consolidated Seasonal Rainfall Forecasts

- In the Pacific Islands “Water is Gold”
- PEAC provides probabilistic outlook of seasonal rainfall forecasts from output of six dynamical model and two statistical models (including PEAC CCA)
 - Visual interpretation of current and forecast conditions
- Forecasts are used to plan water resources, anticipate tourism, plan crops, prepare for a drought situation etc.



Current Methodology

Location	UKMO	ECMWF	CCA	NASA	NCEP	IRI	Rainfall Outlook	Probabilities	% of Long Term Average
Republic of Palau									
Koror 7' 22" N 134' 32" E	Avg-above	Avg	Avg-below	Avg-below	Avg-below	Climatology	Avg-below	40:40:20	70
Fed. S									
Yap S								:20	80
Chuuk								:15	80
Pohnpe								:15	85
Rep. o									
Majuro								:20	80
Territo									
Guam								:20	90
Territo									
Pago P								:20	85
State c									
(19.7 - 21.0N 155.0 - 159.5 W)									
Lihue	avg-above	Avg	Avg	Avg	Avg	Avg	Avg	20:50:30	100
Honolulu	NS	Avg	Avg	Avg	Avg-below	Avg	Avg	30:50:20	100
Kahului	NS	Avg	Avg	Avg	Avg	Avg-below	Avg	30:50:20	90
Hilo	avg-above	Avg	Avg	Avg	Avg	Avg-below	Avg	30:50:20	90



Above
Avg-Above
Average
Avg-Below
Below

Climate Forecasts, Warning, and Response Activities

- ❑ **Monthly Teleconference—**
 - ❑ PEAC-forecasts (i.e., sea-level, rainfall, tropical cyclone etc.) are placed for discussion within a PEAC-sponsored teleconference;
 - ❑ The WSO from each of the island communities is invited to attend this conference;
- ❑ Representatives from the forecasting centers are also invited--past, present, and future climatic conditions are brought up;
- ❑ A consensus forecast is achieved ;
- ❑ Seasonal forecasts for rainfall, TC, are expressed as probabilities of occurrence –SL in deterministic format.



- <http://www.prh.noaa.gov/peac/update.php>
(<https://www.facebook.com/peaccenter>)

Summary

This ENSO-based seasonal climate outlook has significantly enhanced the local governance capacity to address water related disasters.

- **5-stage research and operational model--(i) forecasting, (ii) interpretation and message formulation, (iii) warning preparation and dissemination, (iv) responses and feedback, and (v) review and analysis--is an efficient way to generate consensus seasonal climate outlook for hazard management;**
- **Interactive dialogue with “users” is essential and should be continuous**
 - **(“eyeball-to-eyeball” communication important).**

Conclusions

The USAPI region is a classic example of ENSO-based forecasts, warning, and response activities, which has enhanced the local governance capacity to address water related disasters—

Other ENSO-sensitive countries *can benefit from these ENSO-based advanced climate information products for real-time response (adaptation) plan to address disasters!*

ENSO 2015-16 : Nothing but El Niño

