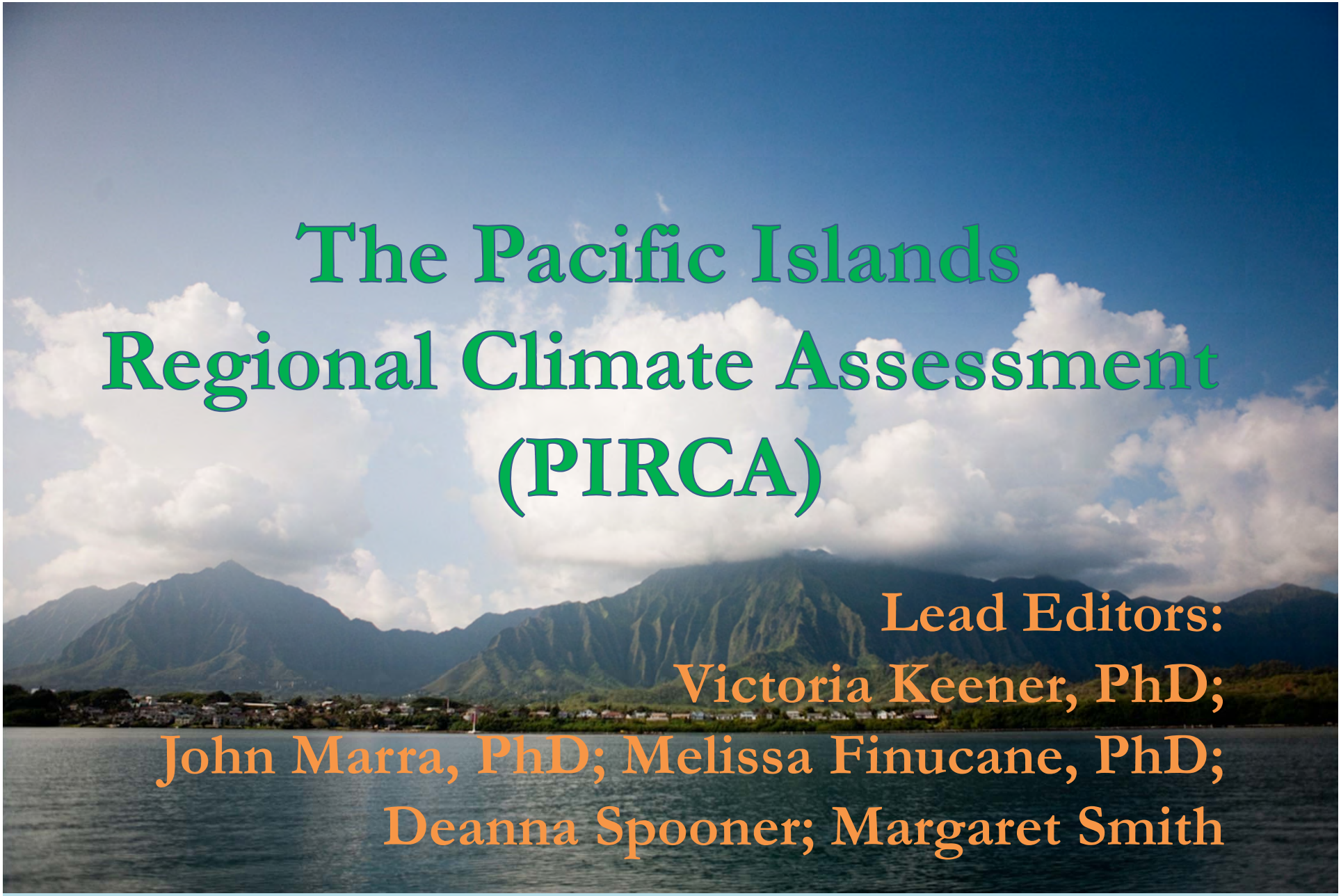


The Pacific Islands Regional Climate Assessment (PIRCA)

Lead Editors:
Victoria Keener, PhD;
John Marra, PhD; Melissa Finucane, PhD;
Deanna Spooner; Margaret Smith

March 20, 2013. CWRM Meeting Briefing.

Photo by Diana Kim

National Climate Assessment

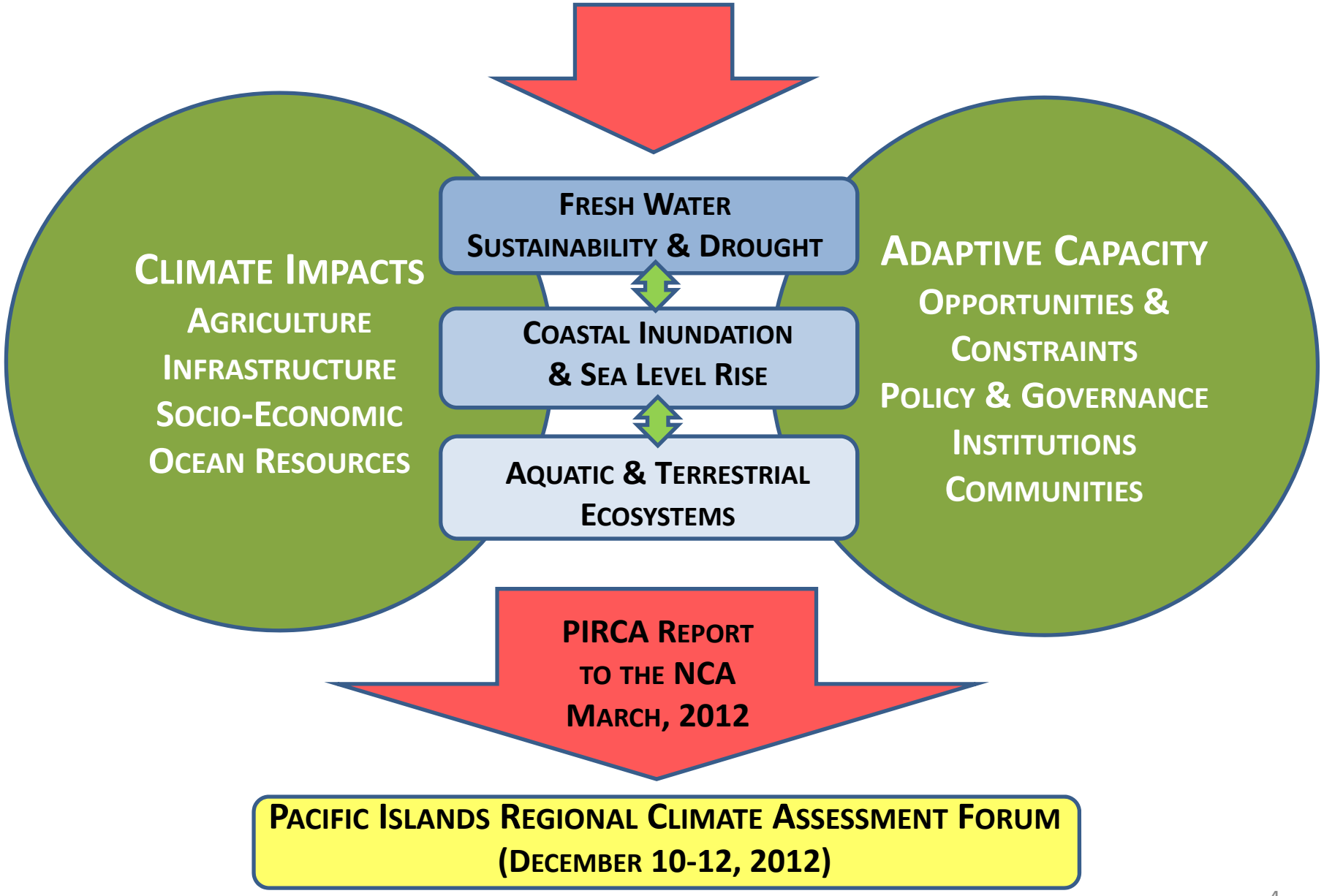
U.S. Global Change Research Program

- US Global Change Research Act of 1990
- Help federal government prioritize science investments
- Draft NCA chapters out for review **until April 12, 2013**
  - **http://ncadac.globalchange.gov/**
  - **Chapter 23: Hawaii and the US Affiliated Pacific Islands**

More on the NCA at http://assessment.globalchange.gov

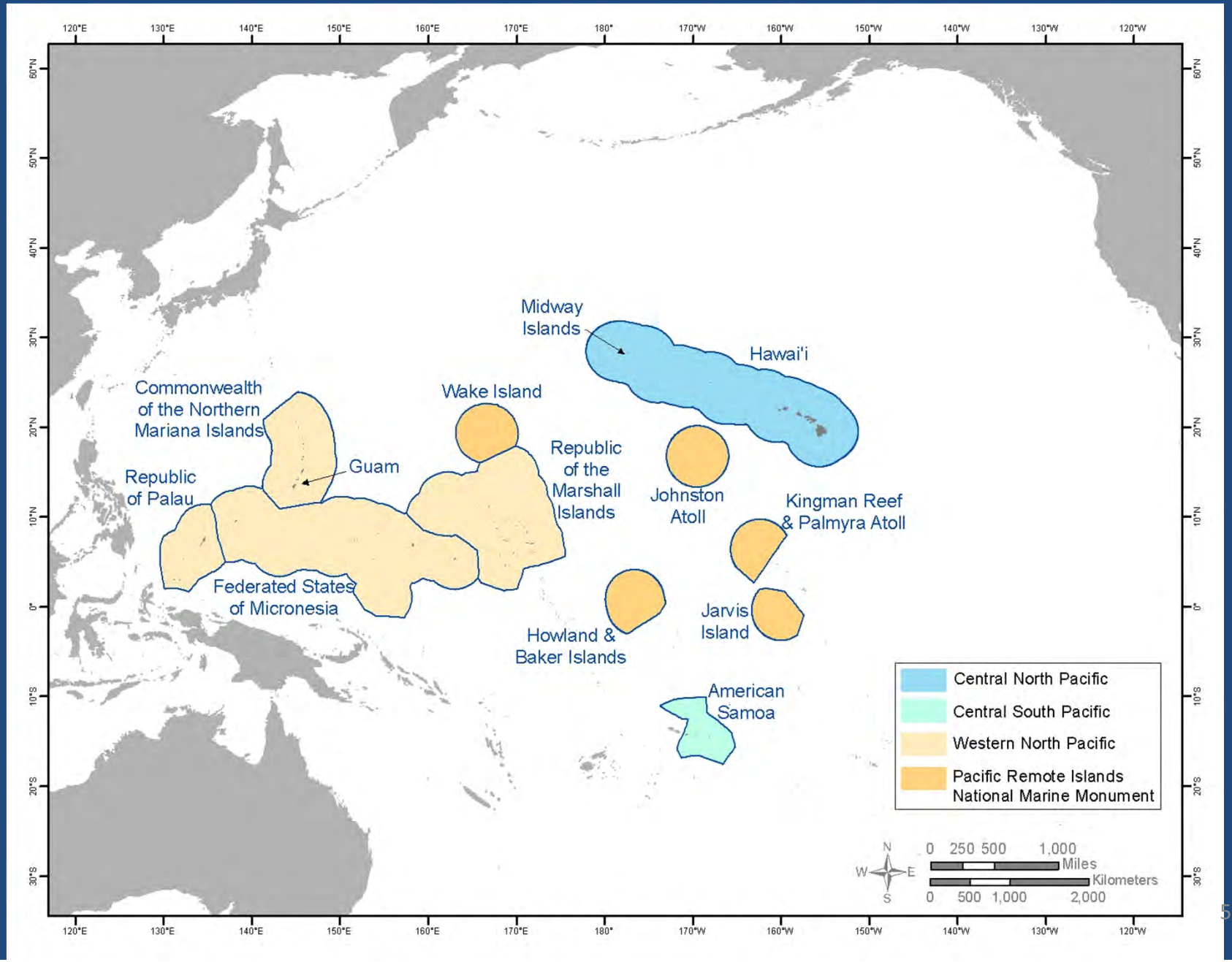
Collaborators

Regional Climate Prognoses: (1) Western North Pacific (2) Central North Pacific (3) Central South Pacific

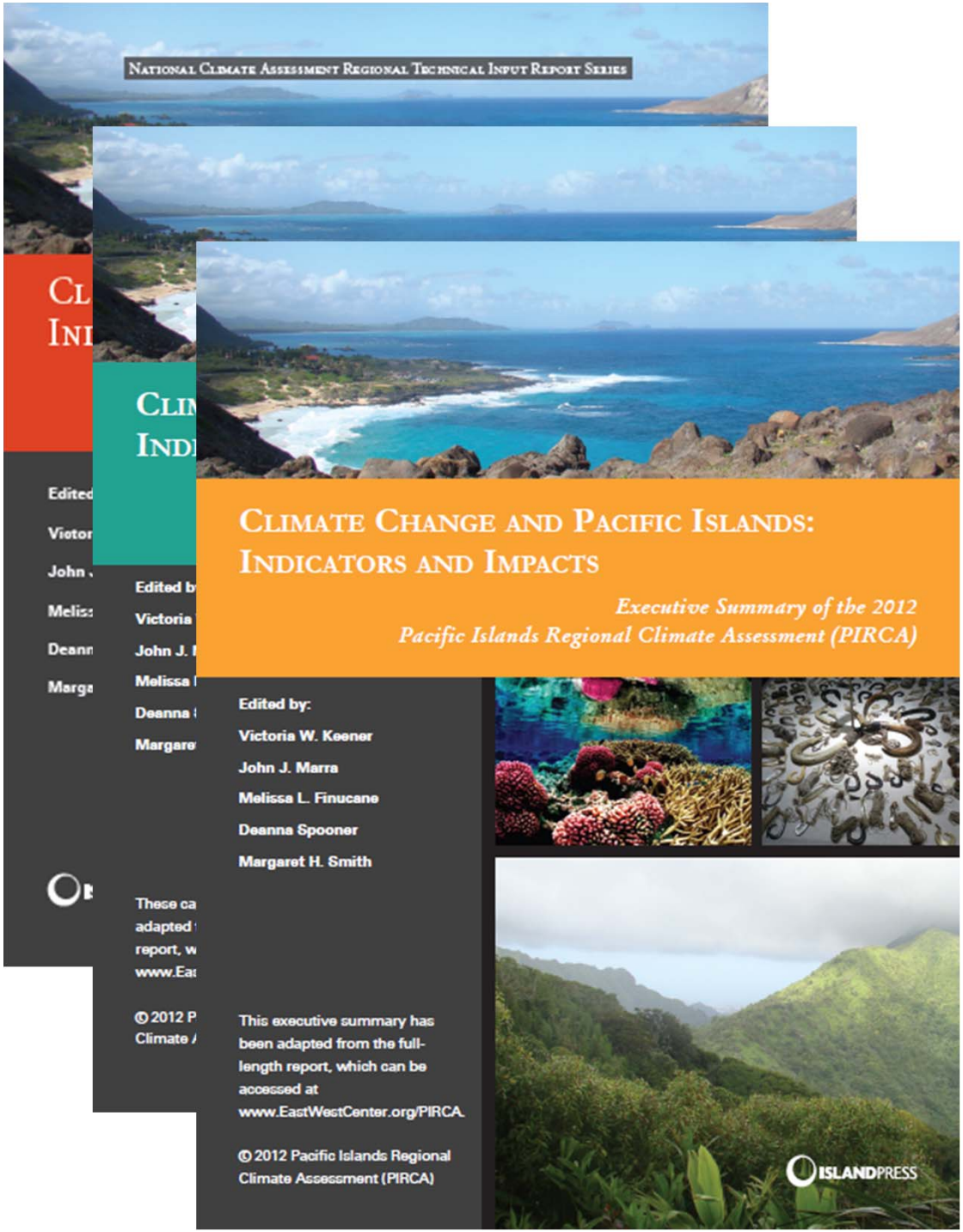


(Figure courtesy Victoria Keener, East-West Center)

Geographical Scope



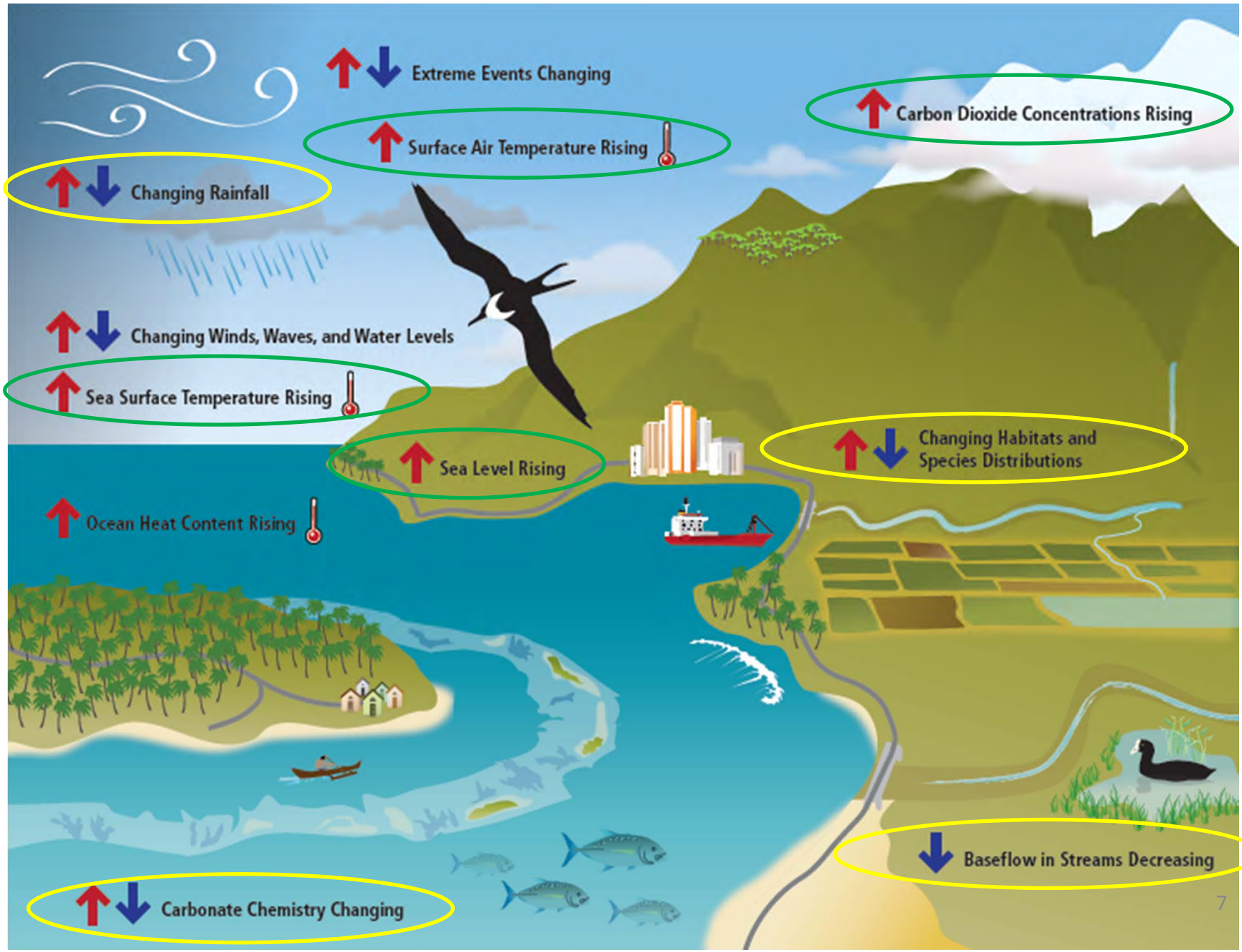
(Figure courtesy of Miguel Castrence, East-West Center)



Products

- **DOWNLOAD: www.eastwestcenter.org/PIRCA**
- Climate Change and Pacific Islands: Indicators and Impacts
- Case Studies
- Executive Summary
- NCA Pacific Islands chapter (2013)
- PIRCA Impacts & Adaptations Fora
  - Honolulu, Dec. 2012
  - Suva, Fiji, Jan. 2013

Indicators of a Changing Climate in the Pacific Islands Region

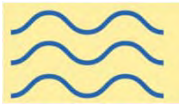


(Figure courtesy Susan Yamamoto, GeoVision)

Key Messages

Average, max, and min air temperatures rising

Fresh water supplies more limited



Coastal flooding and erosion

Changes in marine ecosystems

Native plant & animal stress/extinction

Increasing migration

Threats to agriculture & indigenous cultures

Changing rainfall amounts and patterns

Changing frequency and intensity of wind, waves, and storms

Images courtesy: Susan Yamamoto, US FWS, Miguel Castrence, Melissa Finucane)

Hazard Mitigation Plans

Table 1-2: Existing hazard mitigation plans in Hawai'i and the US-Affiliated Pacific Islands

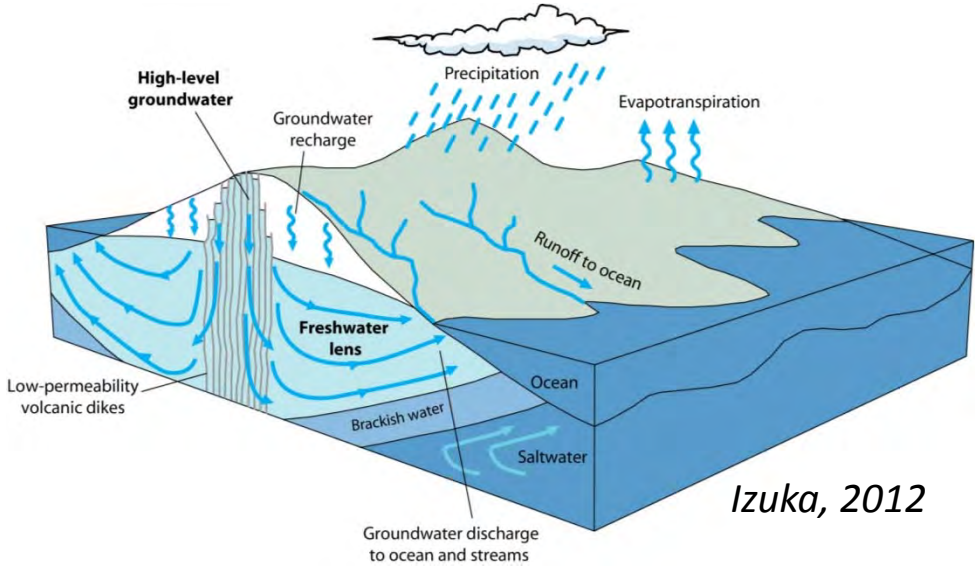
Location	Plan Type	Year Created/ Updated
American Sāmoa	American Sāmoa Revision and Update of the Territory Hazard Mitigation Plan	2008
Commonwealth of the Northern Mariana Islands	Commonwealth of the Northern Mariana Islands Standard State Mitigation Plan	2010
Guam	2008 Guam Hazard Mitigation Plan	2008
State of Hawai'i	State of Hawai'i Multi-Hazard Mitigation Plan, 2010 Update	2010 (Update)
County of Hawai'i	County of Hawai'i Multi-Hazard Mitigation Plan	2010
County of Kaua'i	Kaua'i County Multi-Hazard Mitigation Plan, 2009 Update	2009
County of Maui	Maui County Multi-Hazard Mitigation Plan, 2010, Volumes I and II	2010
County of Honolulu	Multi-Hazard Pre-Disaster Mitigation Plan for the City & County of Honolulu, Volumes I and II	2010

Difficult to include cc impacts in modeling risk and vulnerability – many data sets too short-term

PIRCA 2012, pg. 30

Freshwater Supplies are Limited and Threatened

- Pacific Islands have **limited and fragile freshwater resources**, making them more vulnerable to climate stresses than continents

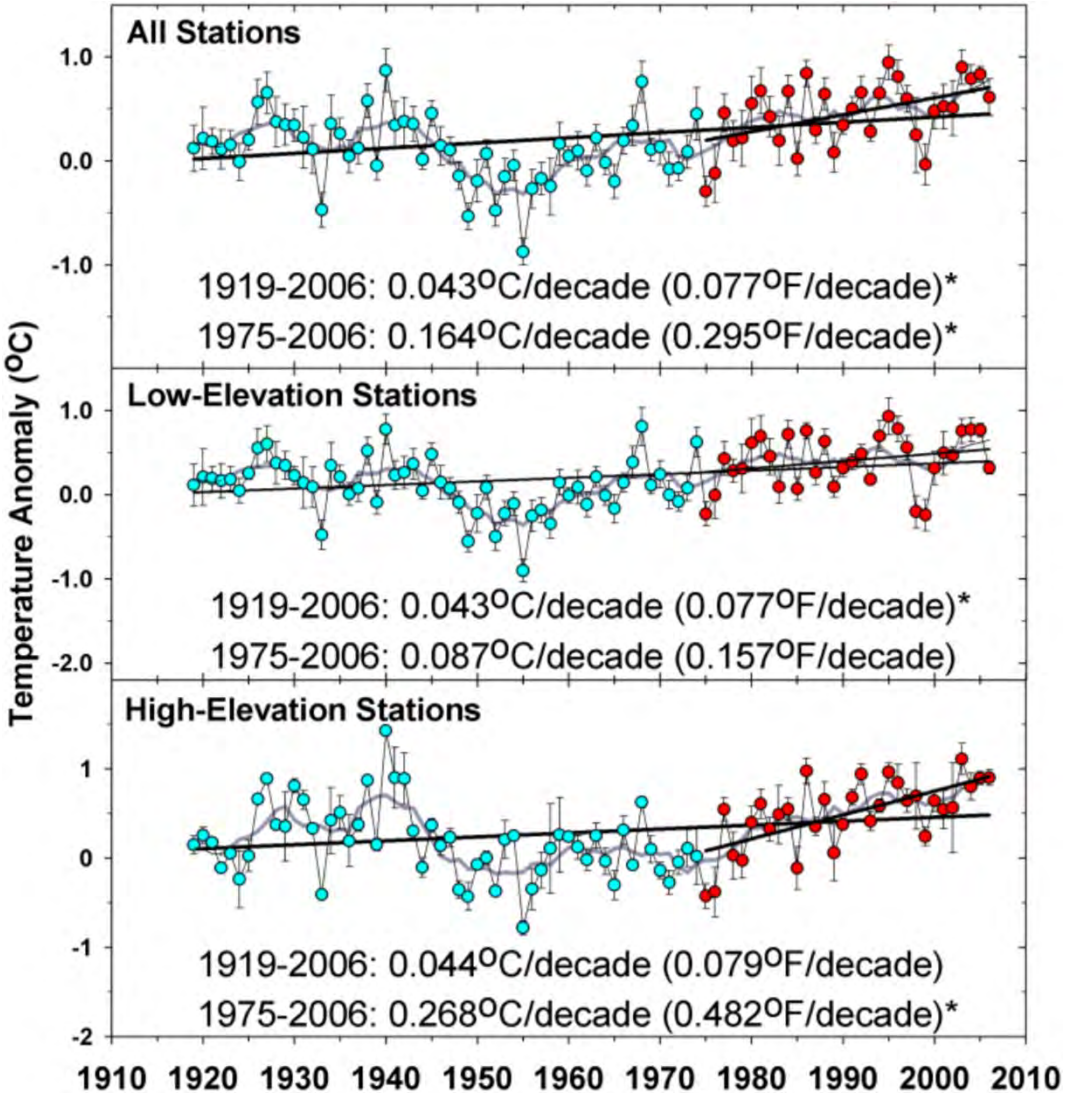


Izuka, 2012

- The Pacific Islands region has **high natural climate variability**. This makes it difficult to detect long-term regional climate trends and make accurate predictions
- To accurately assess trends in water resources as climate changes, **more data and basic monitoring** are severely needed

Air Temperature is Rising

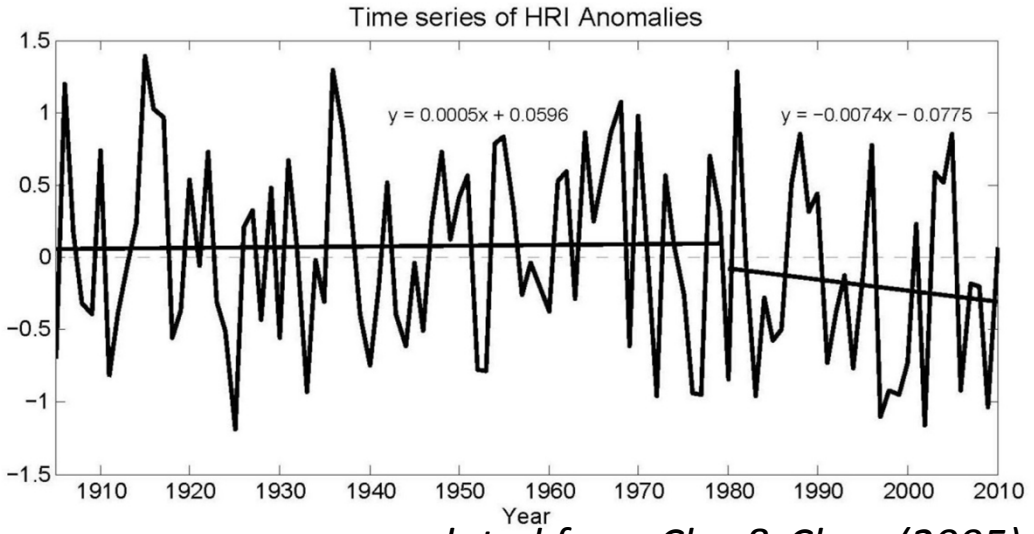
- **Average, min, and max air temperature has risen significantly** in Hawai‘i in the past 100 years
- This has accelerated in the past 30 years
- Increasing air temperature is **more rapid at high-elevations** (>0.5 mile above sea level)



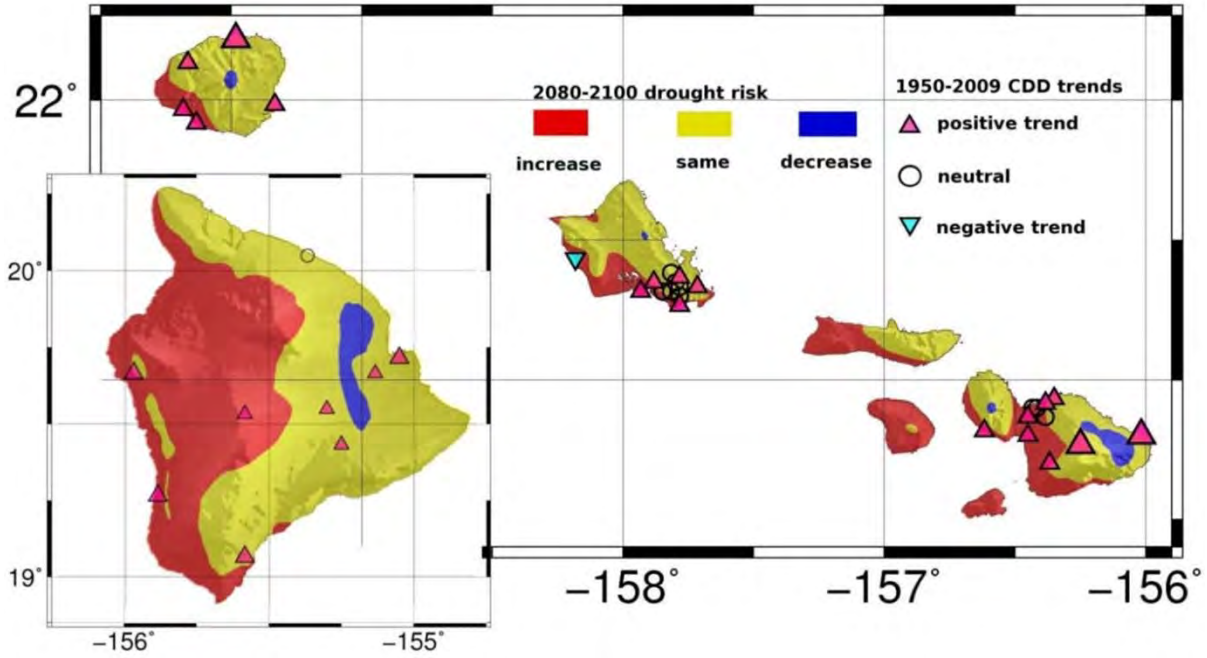
Giambelluca et al, 2008

Precipitation & Drought Patterns are Changing

Annual precipitation has decreased significantly in the past 30 years in Hawai‘i



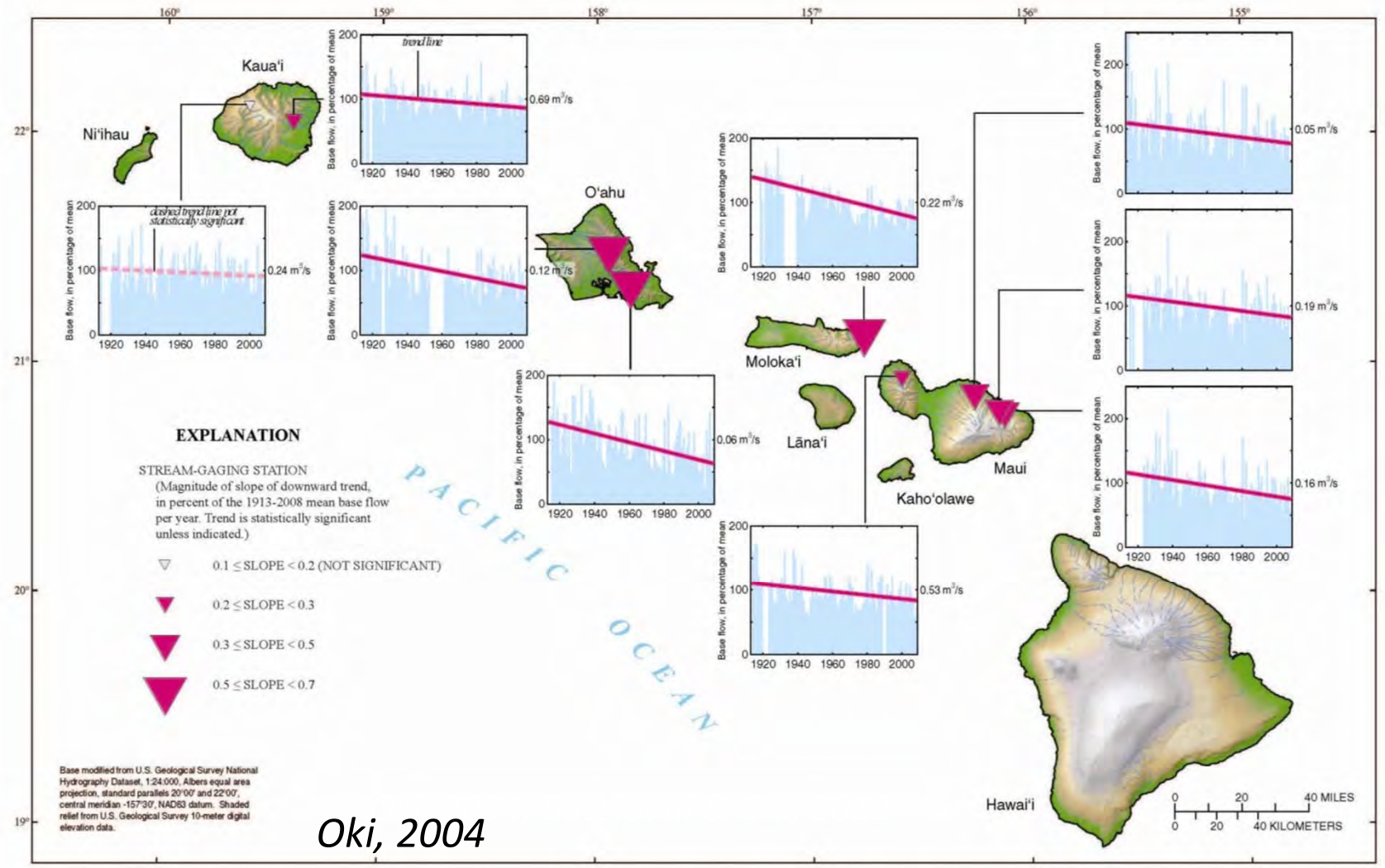
updated from Chu & Chen (2005)



PIRCA 2012, Courtesy Oliver Elison Timm

In the past 30 years**, all Hawaiian Islands have experienced greater numbers of consecutive dry days**, and fewer days of intense rainfall

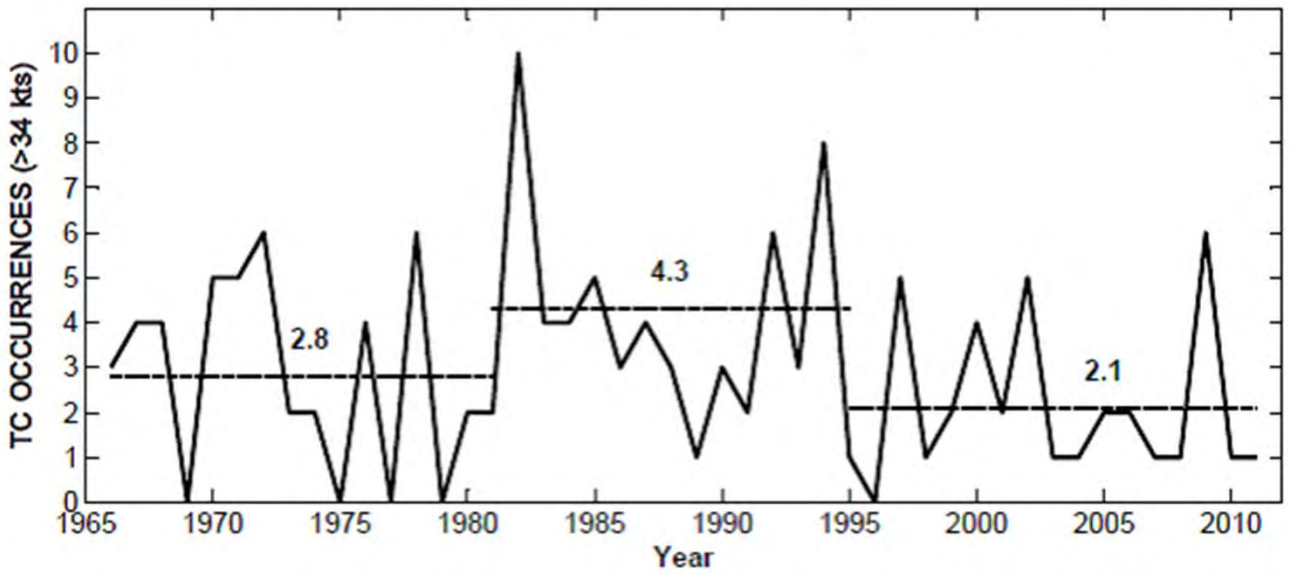
Base Flow in Streams is Decreasing



Oki, 2004

In Hawai'i, **base flow, the groundwater component of streamflow,** has shown **significant downward trends** of 20-70% in the past 100 years

Precipitation Extremes

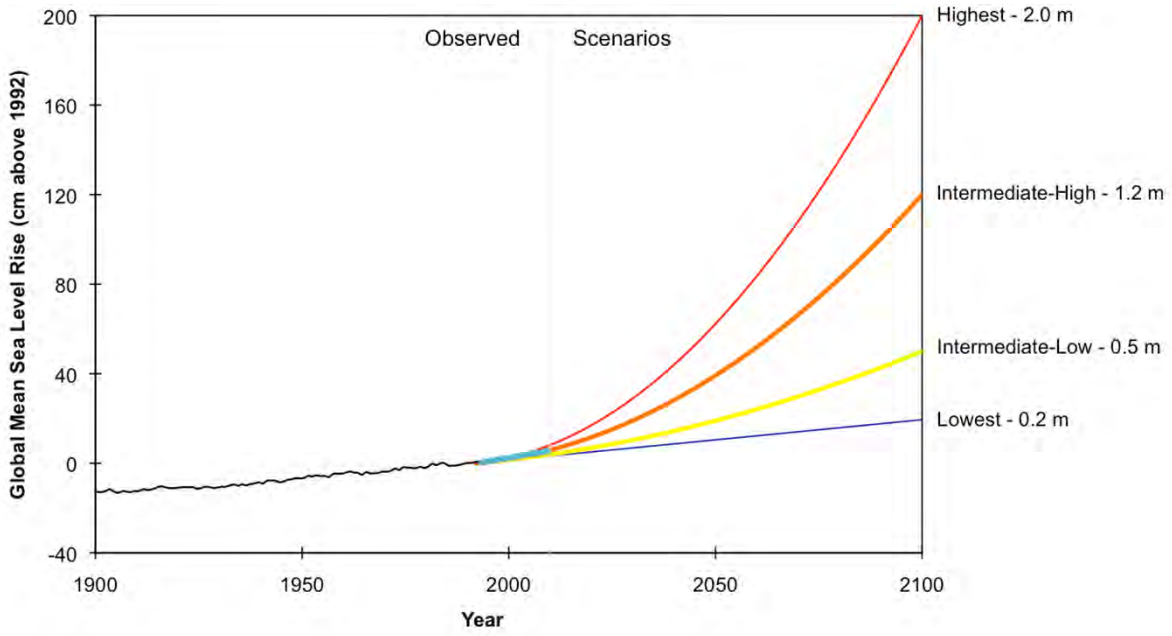


Updated from Chu, 2002

- We have entered a period of **fewer average storms** in the Central North Pacific storm basin since the mid-1990s
- Generally, future extreme rainfall in Hawaii is projected to be **less frequent**, but storms that do hit will be **more intense**

Sea Level is Rising

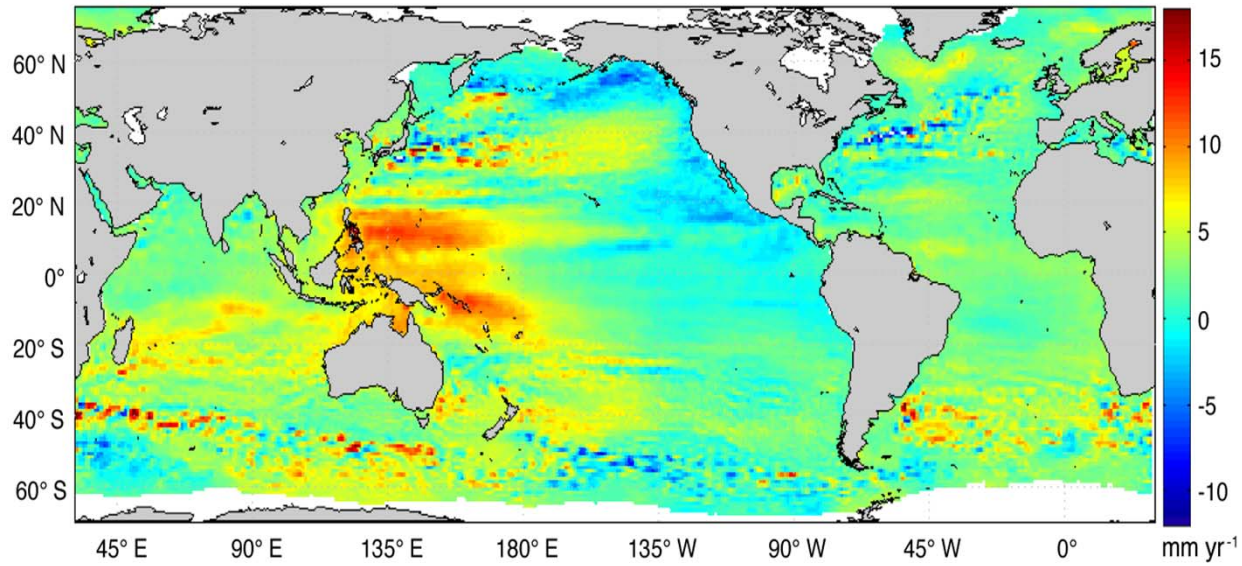
- Since the 1990s, the rate of **globally averaged sea-level rise** has been **~0.13 inches per year**
- This is **twice the estimated rate** for the 20th century as a whole



Parris et al., in press

- Climate **model projections** (that do not include ice-sheet contributions) **are for an 6 to 24 inch rise in global sea level** by 2100

Sea Level Rise (SLR) is Non-uniform & Non-steady



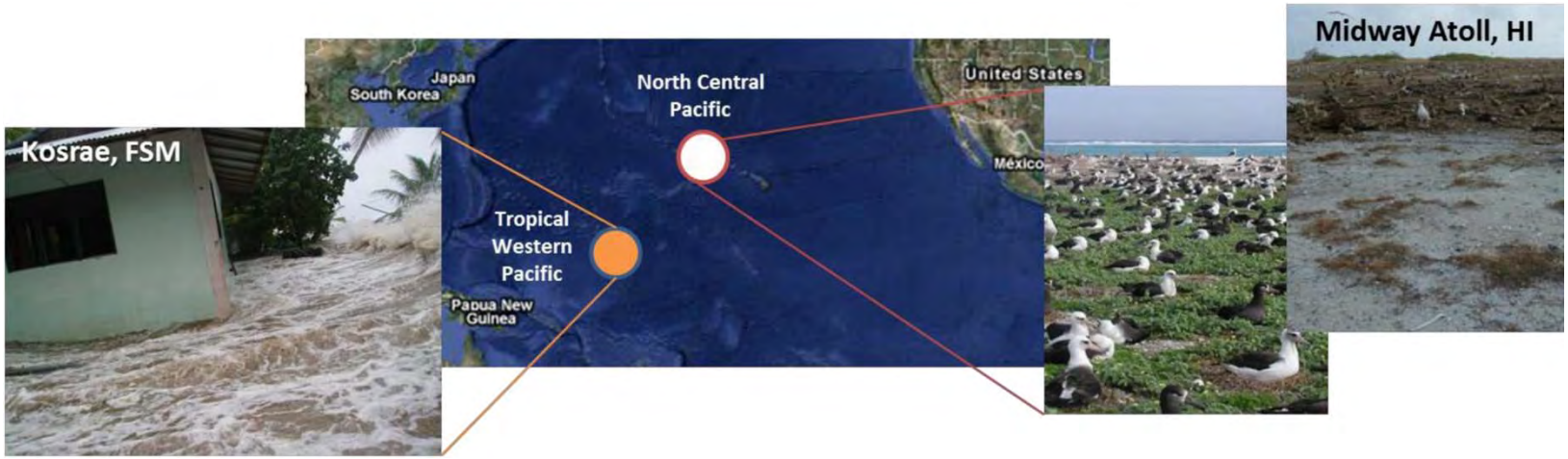
Sea-level trend for 1993-2010 from Aviso altimeter.

Merrifield 2011

- **The highest rates of regional SLR have occurred in the western tropical Pacific**. Since the early 1990s, natural climate variability has increased the strength of the trade winds
- **There will be increased stress on western Pacific islands** due to SLR, combined with seasonal high tides, the occurrence of La Niña, and storm events and waves

Increasing Average Sea Level Means More Frequent Extreme Sea Levels

- **Extreme sea level events** occur when high tides combine with some non-tidal change in water level (such as from tropical and extra-tropical storms)



Images courtesy of USFWS, Kosrae image courtesy of Kosrae Islands Resource Management Agency staff

- Increased coastal inundation from extreme water level events will **threaten communities and wildlife**

Increased Flooding and Erosion Threaten Natural and Built Environments

- Coastal structures
- **Airports**
- Groundwater supply
- Harbor operations
- **Agricultural productivity**
- Waste water systems
- **Sandy beaches**
- Coral reef ecosystems
- Cultural resources
- **Nesting habitat**

- **Atolls are especially vulnerable** over the near to mid-term (next 25 to 50 years)

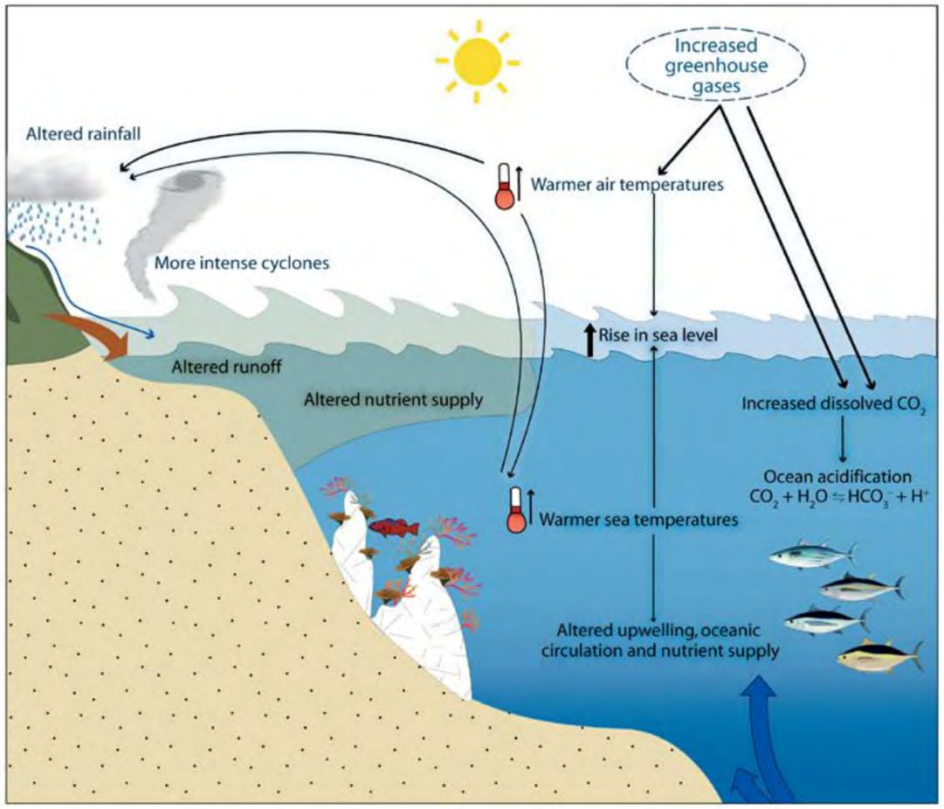
Climate change will force human migration

- There is no single legal entity that governs climate migrants
- Projections of the number of global climate migrants by 2050 range from **25 million to 1 billion**
- Unlike other populations, **many Pacific Islanders will not be able to migrate domestically**, as their entire country is only a few feet above sea level
- (3/9/13) PACOM Chief calls climate change **biggest security threat to Pacific Region**:

"**The ice is melting and sea is getting higher**," Locklear said, noting that 80 percent of the world's population lives within 200 miles of the coast. The US military, he said, is beginning to reach out to other armed forces in the region about the issue.

http://www.bostonglobe.com/news/nation/2013/03/09/admiral-samuel-locklear-commander-pacific-forces-warns-that-climate-change-top-threat/BHdPVCLrWEMxRe9IXJZcHL/story.html

Native plant and animal populations will be increasingly stressed

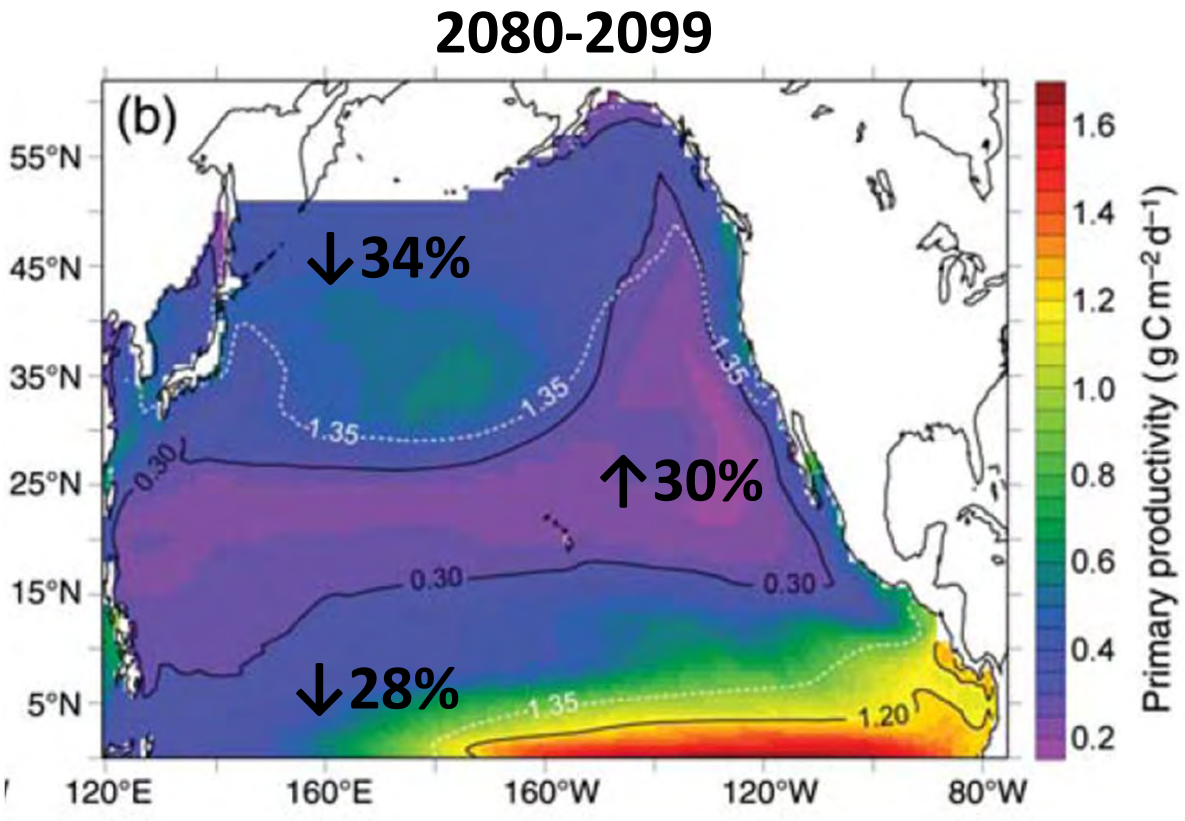


Generalized effects of increased greenhouse gases on oceanic and coastal ecosystems in the tropical Pacific, *Bell et al., 2011*

- Different **impacts are interconnected** and will combine to alter ecosystem function
- Rising air temperatures, especially at high elevations, could **exacerbate invasive species** problems
- Increasing sea surface temperatures are correlated with **more coral bleaching** events

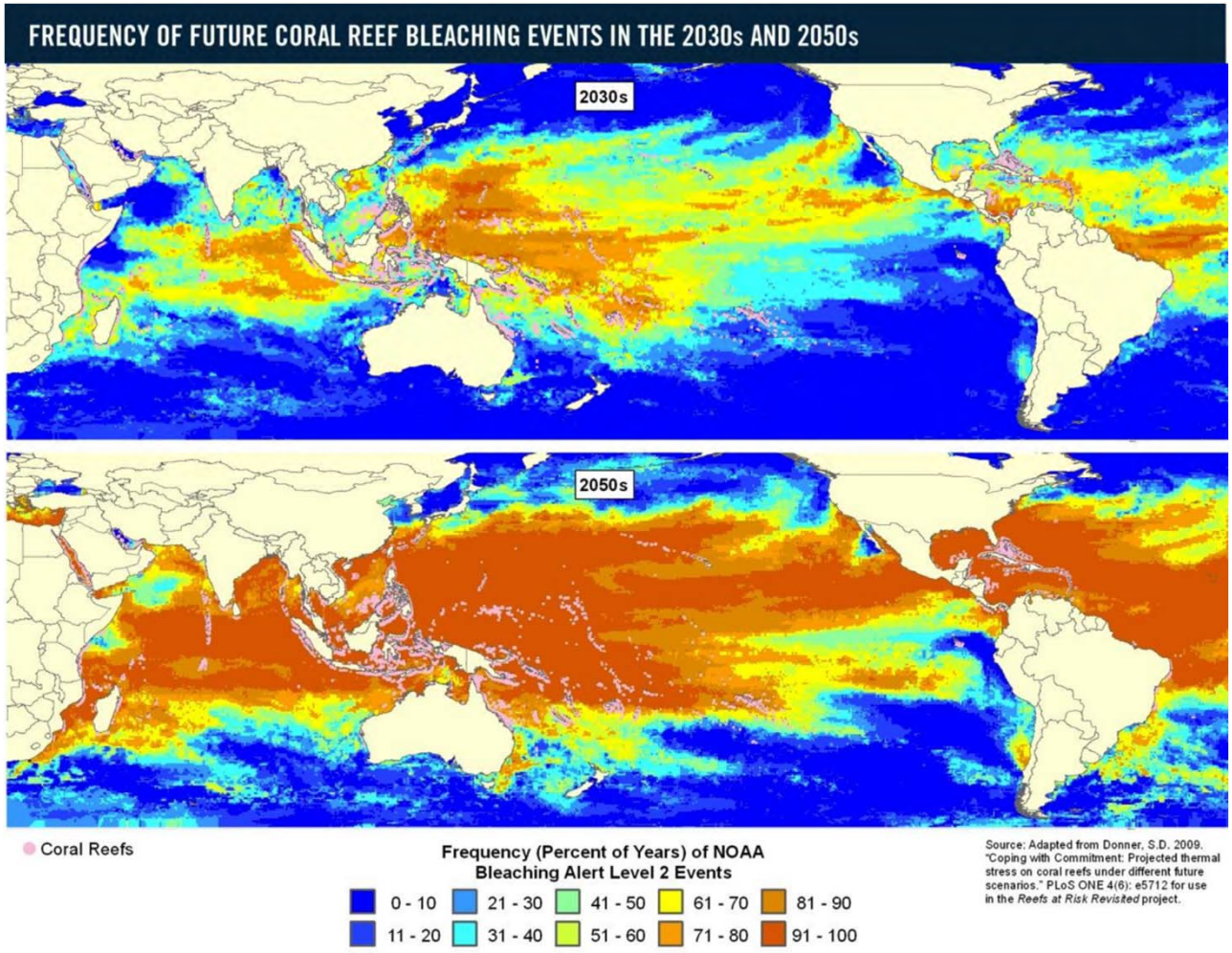
The Distribution of Regional Coastal and Pelagic Fisheries Will Shift

- Changing ocean temperatures will **shift habitats throughout the food chain**
- Some countries fisheries **will prosper** from these shifts, and some will be **negatively impacted**



Projected changes in primary production, From Polovina et al., 2011

By 2050, many coral reefs may bleach annually



Future reef bleaching frequency based on IPCC A1b (business as usual) emissions scenarios, Burke et al., 2011; data adapted from Donner, 2009.

Low Islands are at High Risk

- Sea-level rise, wave overwash, and coastal inundation will contribute to **loss of natural and built ecosystems**

- These changes will eventually **reduce or eliminate endemic terrestrial species and nesting habitat** on many small islands

High Island Ecosystems are Changing

The ʻiʻwi (*Vestiaria coccinea*) Courtesy of Daniel W. Clark.

- **Existing climate zones are projected to shift**, generally upslope, **with some eventually disappearing**

- **High elevation ecosystems are at high risk**, due to increase in ambient temperature and decrease in rainfall

Haleakala silversword (*Argyroxiphium sandwicense subsp. macrocephalum*) Courtesy of NPS

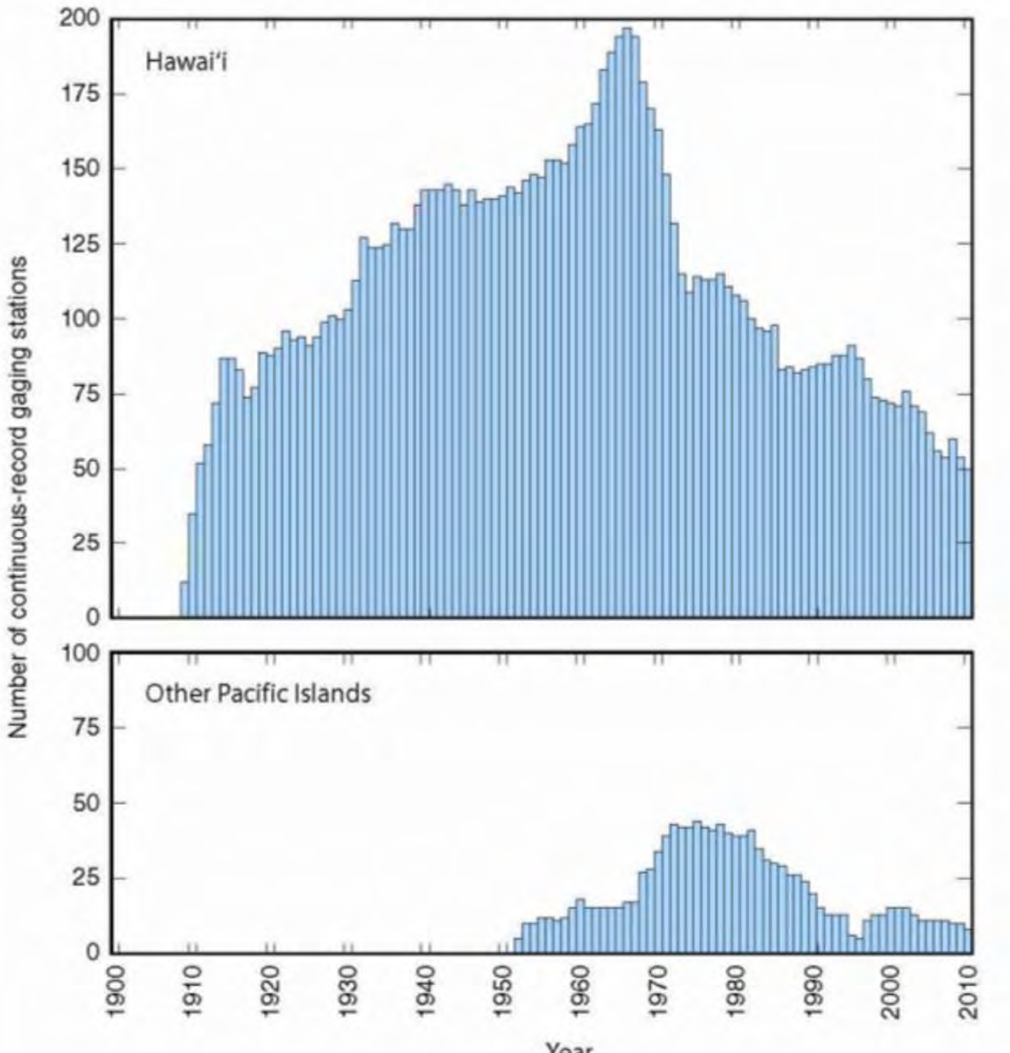
The Changing Climate Poses Serious Consequences for Regional Cultures

- **Traditional lifestyles and indigenous cultures** will be increasingly stressed
- **Drought and saltwater intrusion threatens traditional food sources**, and changing ocean conditions will likely **threaten subsistence fisheries**
- Inundation from **sea-level rise** may destroy coastal artifacts and structures or **the entire land base** associated with a particular culture
- Climate-related environmental deterioration coupled with socioeconomic motivations will lead communities to **migrate to a new location**

Data & Observations are Needed to Support Adaptation and Management

- The Pacific Islands region has experienced a **decrease in climate monitoring stations**
  - Rainfall, streamflow, waves, and ecosystem data are all critical

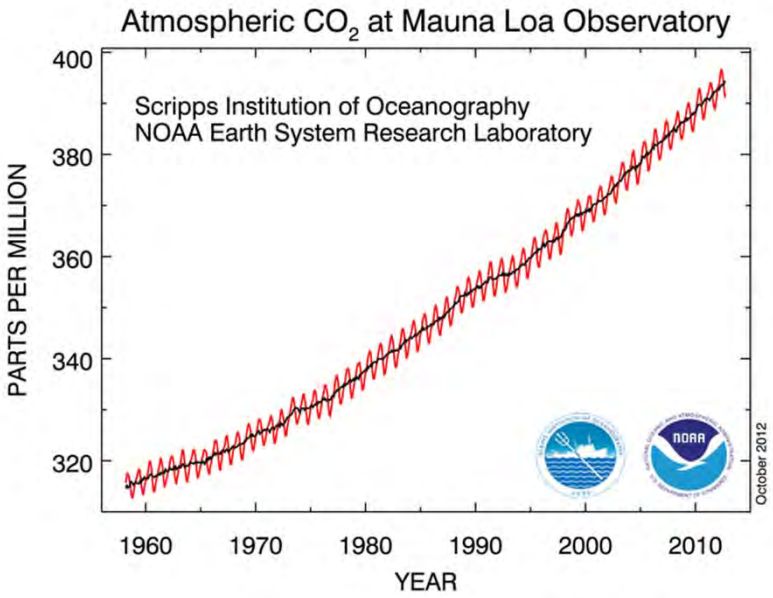
- The ability to assess future climate changes in meaningful detail **is at risk**



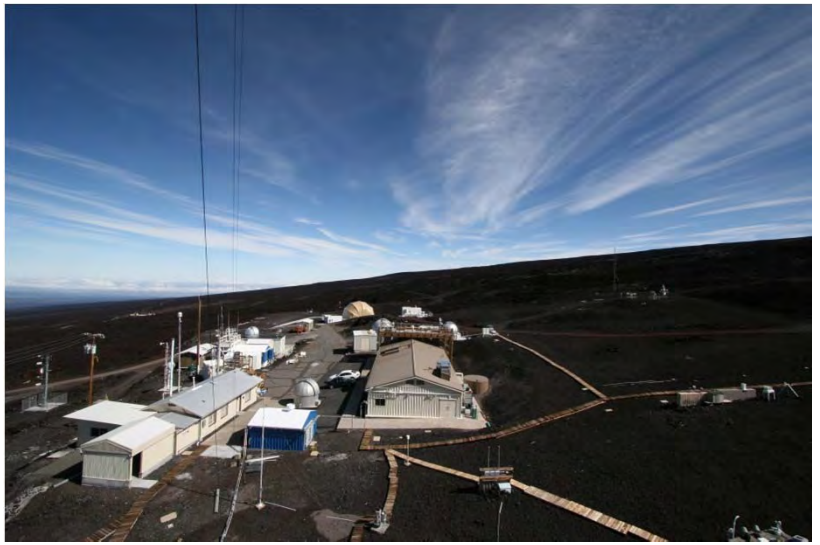
Number of streamgages, USGS Pacific Islands Water Science Center, 2011

The Pacific Region has some of the highest-quality climate data in the world

- The **longest high-quality record** of atmospheric CO_2 in the world



The Keeling Curve record from 1958-2011. Courtesy of Pieter Tans and Ralph Keeling



The Mauna Loa Observatory, © Forest M. Mims III

- Station ALOHA has been collecting **ocean acidification data** for 20+ years
- **HaleNet** collects climate data across the slopes of Haleakalā

Partnerships Between Research Scientists and Decision-Makers are Crucial

- The Pacific Islands face complex and **multidimensional problems**
- **Neither science nor management alone** can adequately address climate change impacts
- Everyone can join the PIRCA sustained assessment process

Ms. Olai Uludong is the incoming Lead Negotiator for the UNFCCC representing the Alliance of Small Island States

Mahalo to all involved and all interested

PIRCA Core Team

Stephen Anthony (USGS PIWSC), Tim Brown (WRCC, DRI), Jeff Burgett (PICCC, FWS), Dolan Eversole (Sea Grant, University of Hawai‘i at Mānoa), Melissa L. Finucane (East-West Center, Pacific RISA), Charles Fletcher (SOEST, University of Hawai‘i at Mānoa), Kevin Hamilton (IPRC, University of Hawai‘i at Mānoa), Victoria W. Keener (East-West Center, Pacific RISA), Dawn Kotowicz (NOAA PIFSC), John J. Marra (NOAA NCDC), Mark Merrifield (JIMAR, University of Hawai‘i at Mānoa), Stephen E. Miller (FWS), Britt Parker (NOAA CRCP), Noriko Shoji (NOAA NMFS), Deanna Spooner (PICCC), Adam Stein (NOAA PSC), William V. Sweet (NOAA COOPS), Jean Tanimoto (NOAA PSC)

And the dozens of experts who participated in workshops and peer-review

To Download the PIRCA Reports:

http://www.eastwestcenter.org/PIRCA

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Photo: Diana Kim, 2012