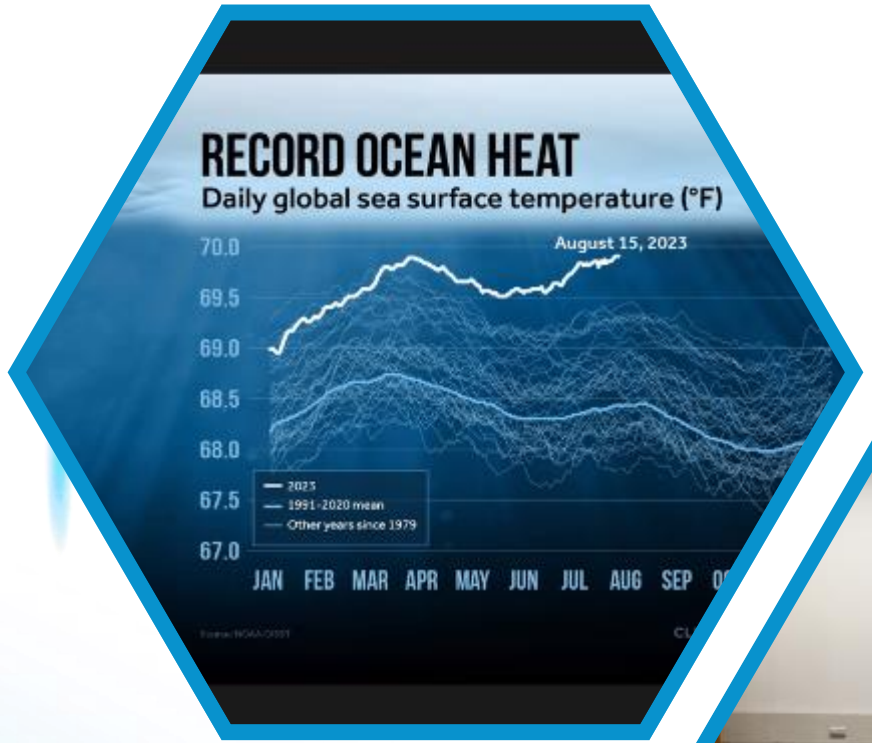
15TH SESSION OF THE PACIFIC ISLANDS CLIMATE OUTLOOK & STAKEHOLDER FORUM

PICOF-15

14 - 15 OCTOBER, 2024

HYBRID
IN-PERSON: NUKU'ALOFA, TONGA
ONLINE: ZOOM

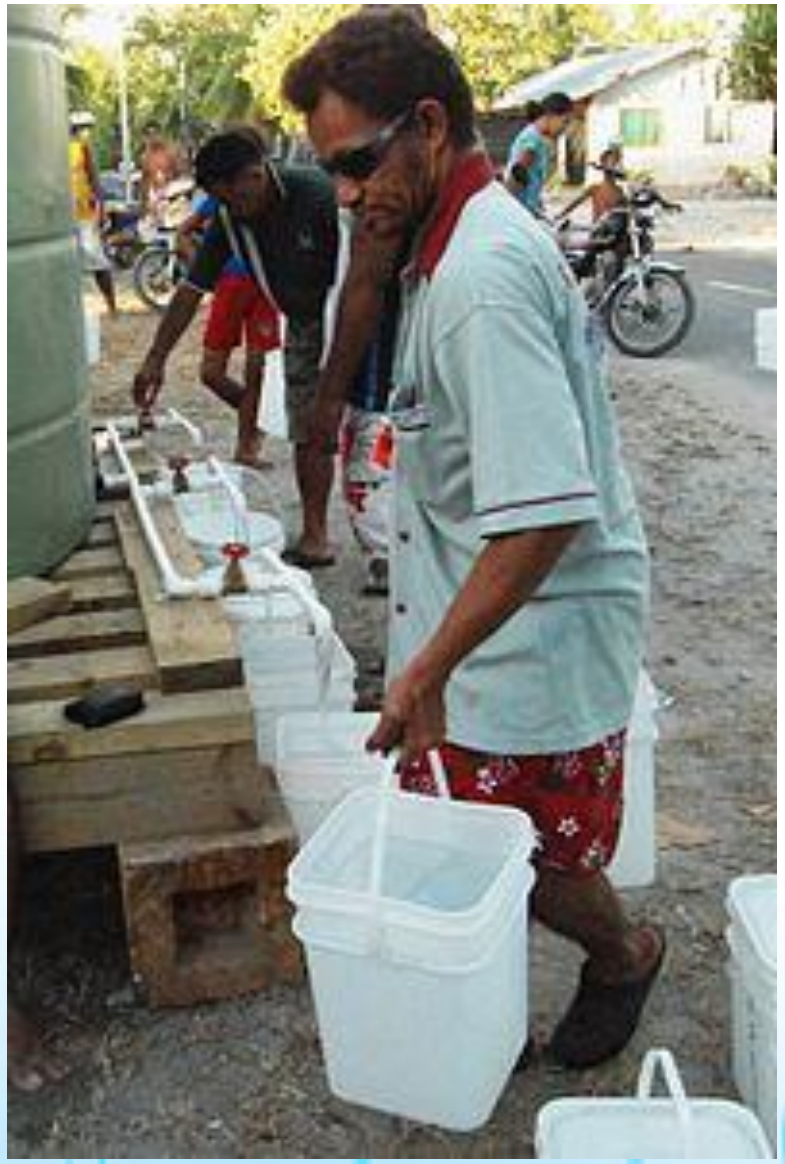


Session 3: Looking Back Long-Term: Status of key variables – Rainfall and Air Temperature

Simon McGree

(Australian) Bureau of Meteorology

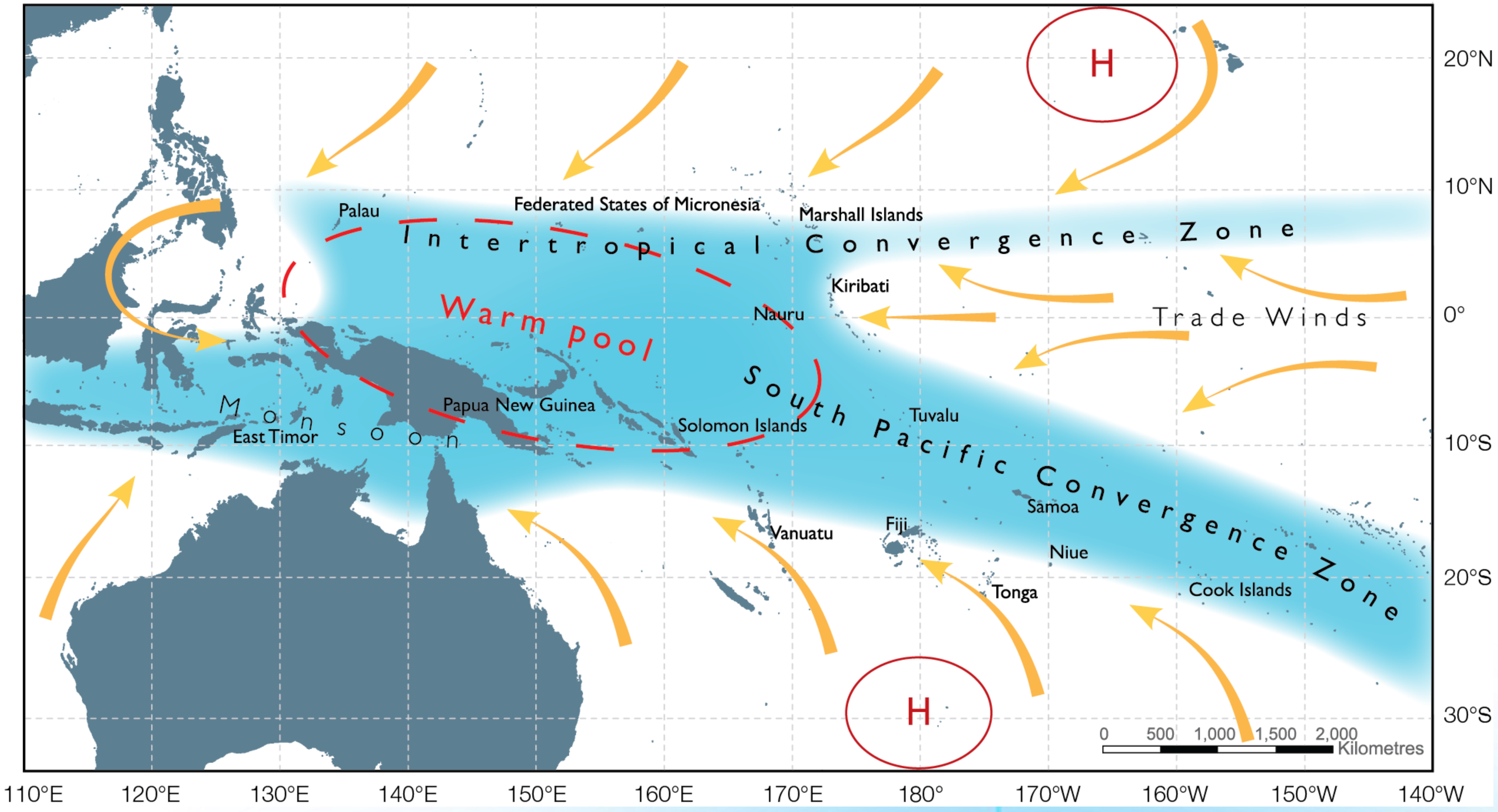
Background - Rainfall



- Wide ranging impacts on humans and ecosystems across the Pacific Islands
- Supplies drinking water on low-lying atolls
- Replenishes freshwater lens
- Supplies water for agriculture
- Changes in rainfall can disrupt these and other natural processes
- Heavy or extreme rainfall can increase or enhance crop damage, soil erosion and floods and reduce the quality of drinking water

(Marra et al., 2022)

Drivers of western Pacific rainfall variability



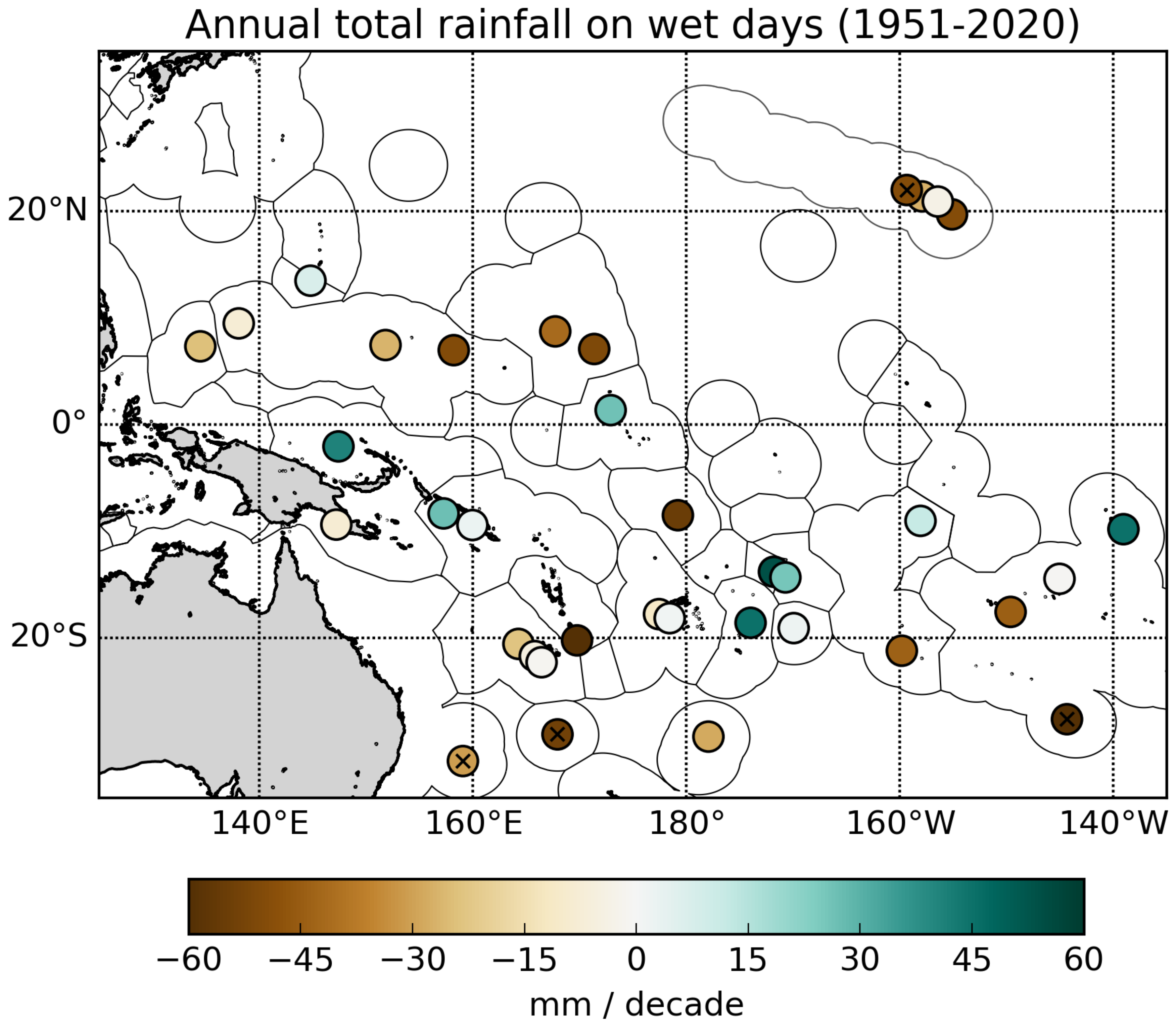
- Pacific rainfall highly variable from decade-to-decade and year-to-year.
- Rainfall strongly influenced by ENSO, position/strength of ITCZ, SPCZ and West Pacific Monsoon
- Frequency of tropical cyclones/depressions and subtropical fronts also important

(BoM and CSIRO, 2011)

WMO

PACIFIC REGIONAL CLIMATE CENTRE NETWORK

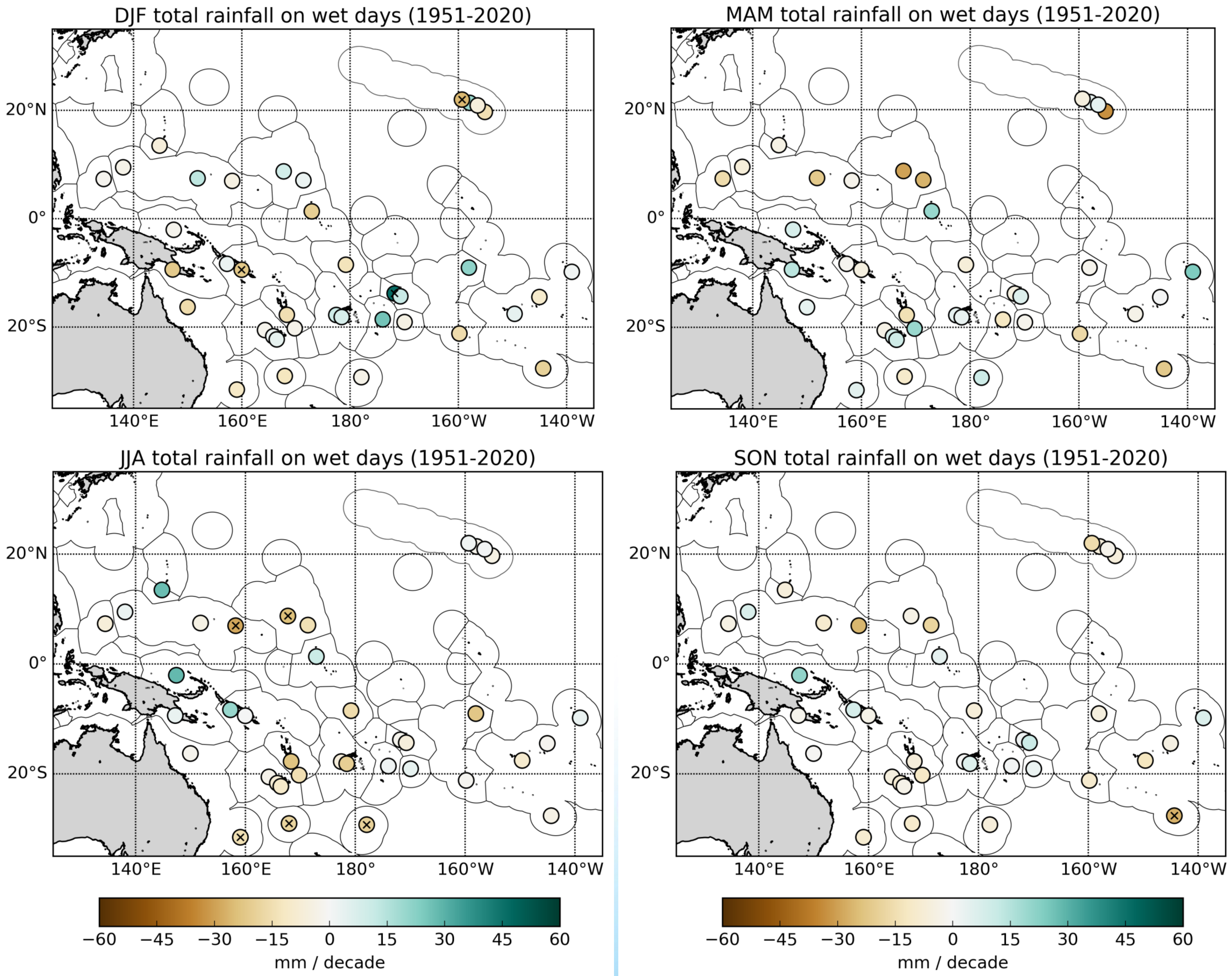
Trends in annual total rainfall (greater or equal to 1mm)



- Mixed rainfall pattern, little change in annual total rainfall at most tropical locations over last 70 years
- Drying trends in Hawai'i and South Pacific subtropics. Consistent with model projections – CSIRO may talk about this later

(Marra et al., 2022)

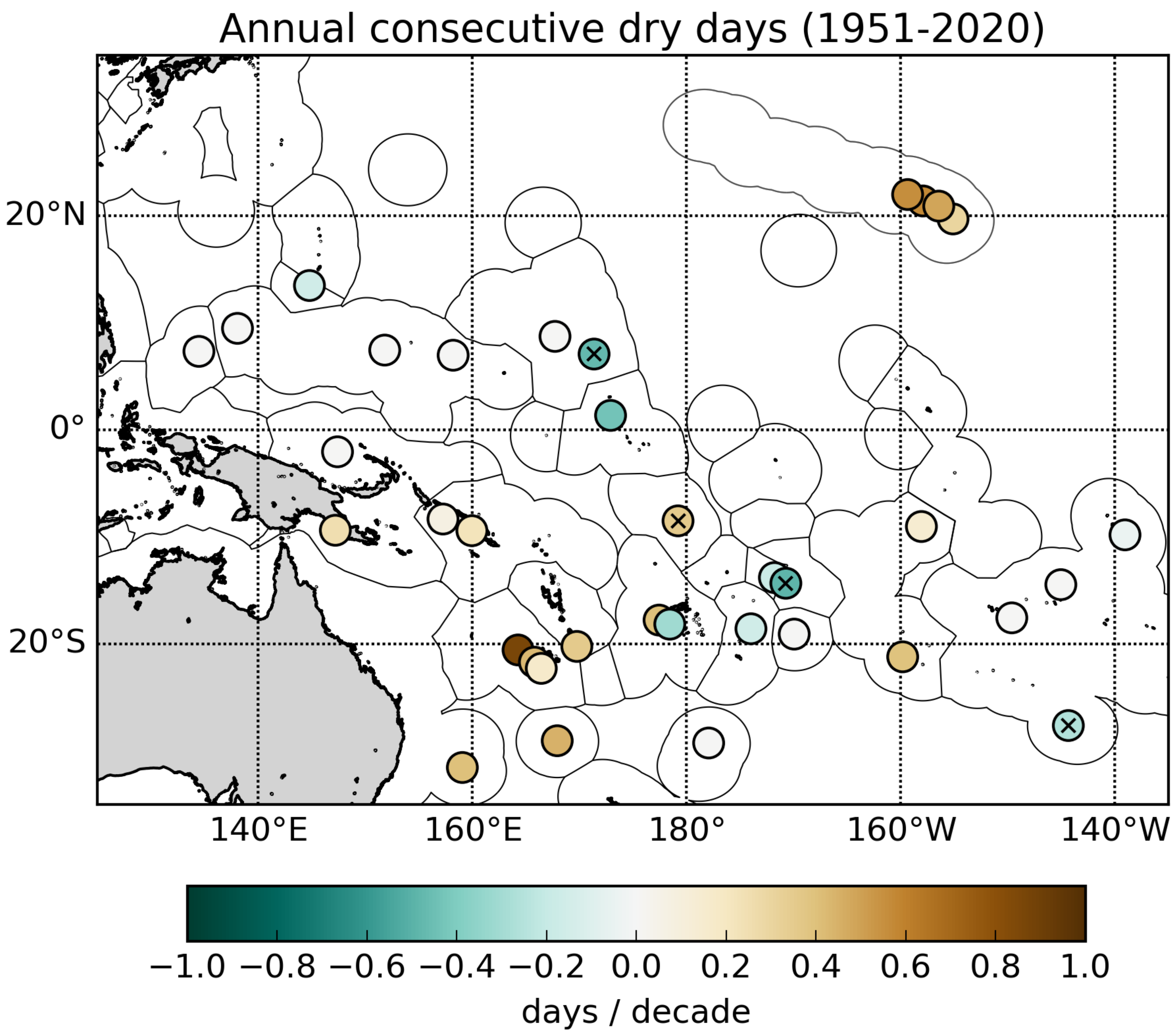
Trends in seasonal total rainfall (greater or equal to 1mm)



- Drying trends in Hawai'i strongest in DJF.
- Drying trends in eastern FSM and RMI in JJA
- South Pacific subtropics drying trends over Jul-Aug in the western Pacific (consistent with southeast Australia), Sep-Nov in the east

(Marra et al., 2022)

Trends in consecutive dry days

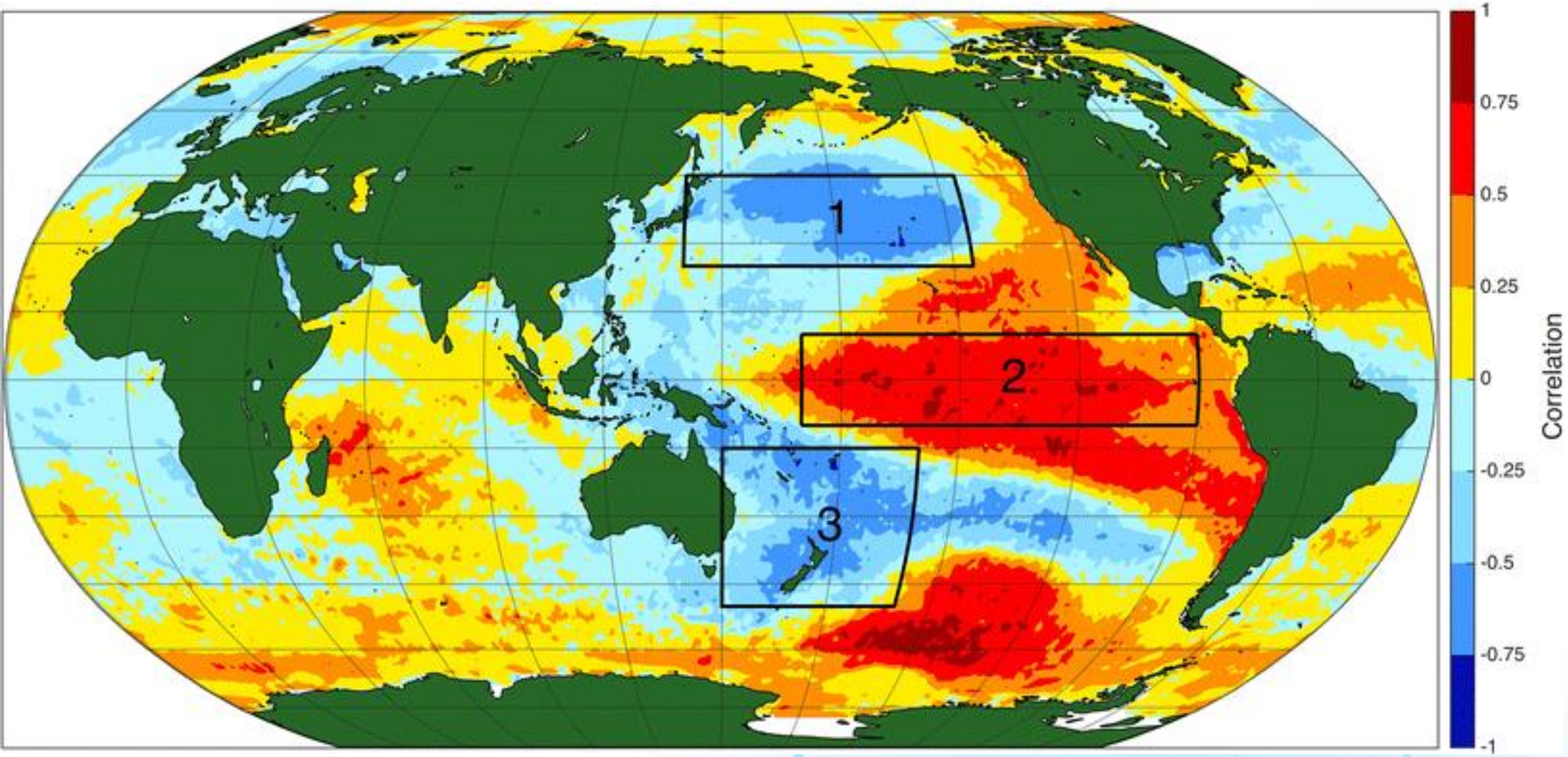


- Change in the longest no. of days in year where rainfall is less than 1 mm (0.04 inches)
- + values = longer periods of low rainfall in recent years
- - values = shorter periods of low rainfall in recent years

- Little change in annual CDD at most locations over the last 70 years

(Marra et al., 2022)

Interdecadal Pacific Oscillation



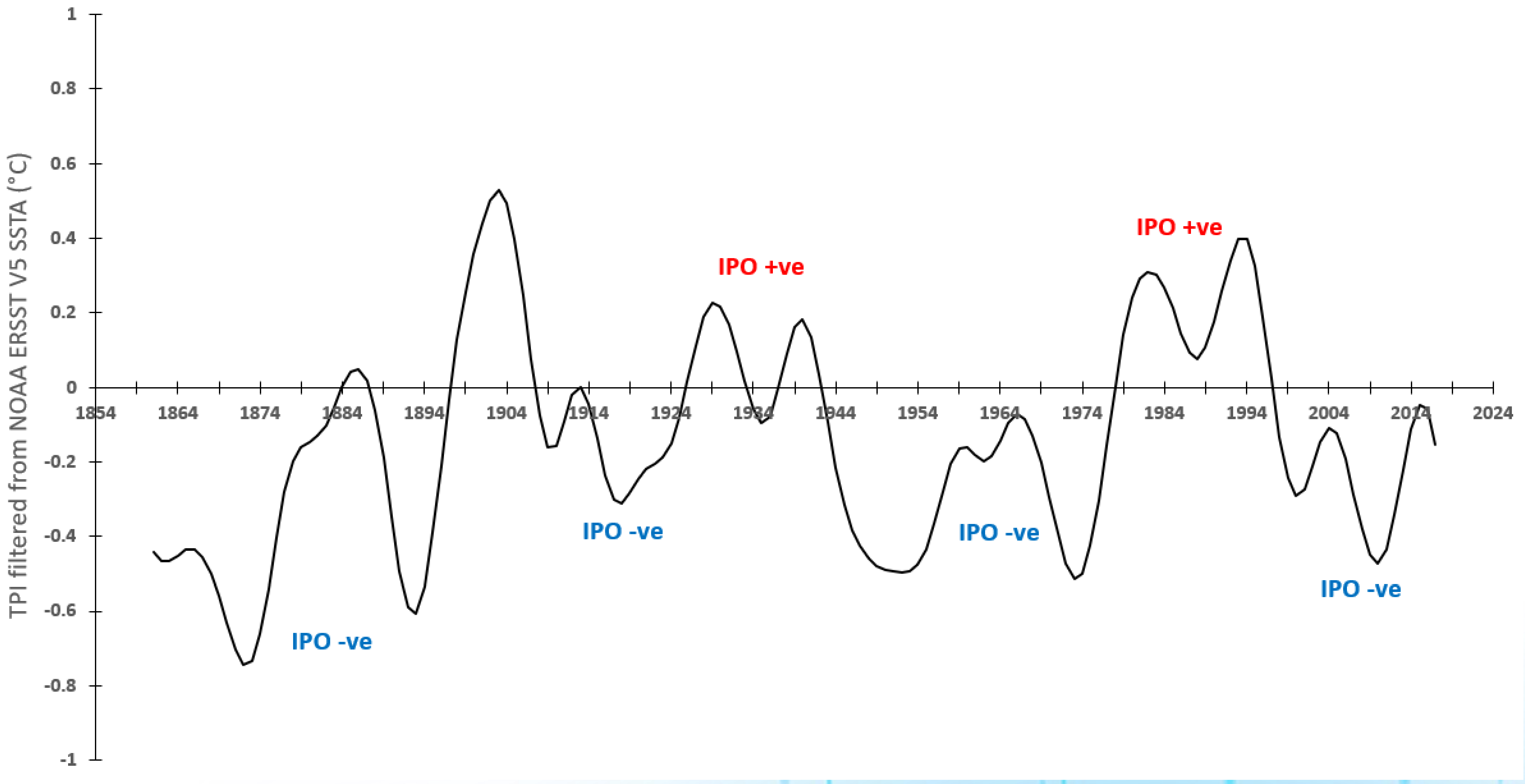
- Tripole Index for the Interdecadal Pacific Oscillation
- IPO measure of interdecadal variability in the Pacific
- Index is based on the difference between the SSTA averaged over the central equatorial Pacific and the average of the SSTA in the Northwest and Southwest Pacific.
- Phases can last 20 to 30 years
- Positive and negative phases affect the strength and frequency of El Niño and La Niña

(Henley et al., 2015), NOAA ERSST V5 data from https://psl.noaa.gov/data/timeseries/IPOTPI/

WMO

PACIFIC REGIONAL CLIMATE CENTRE NETWORK

Interdecadal Pacific Oscillation

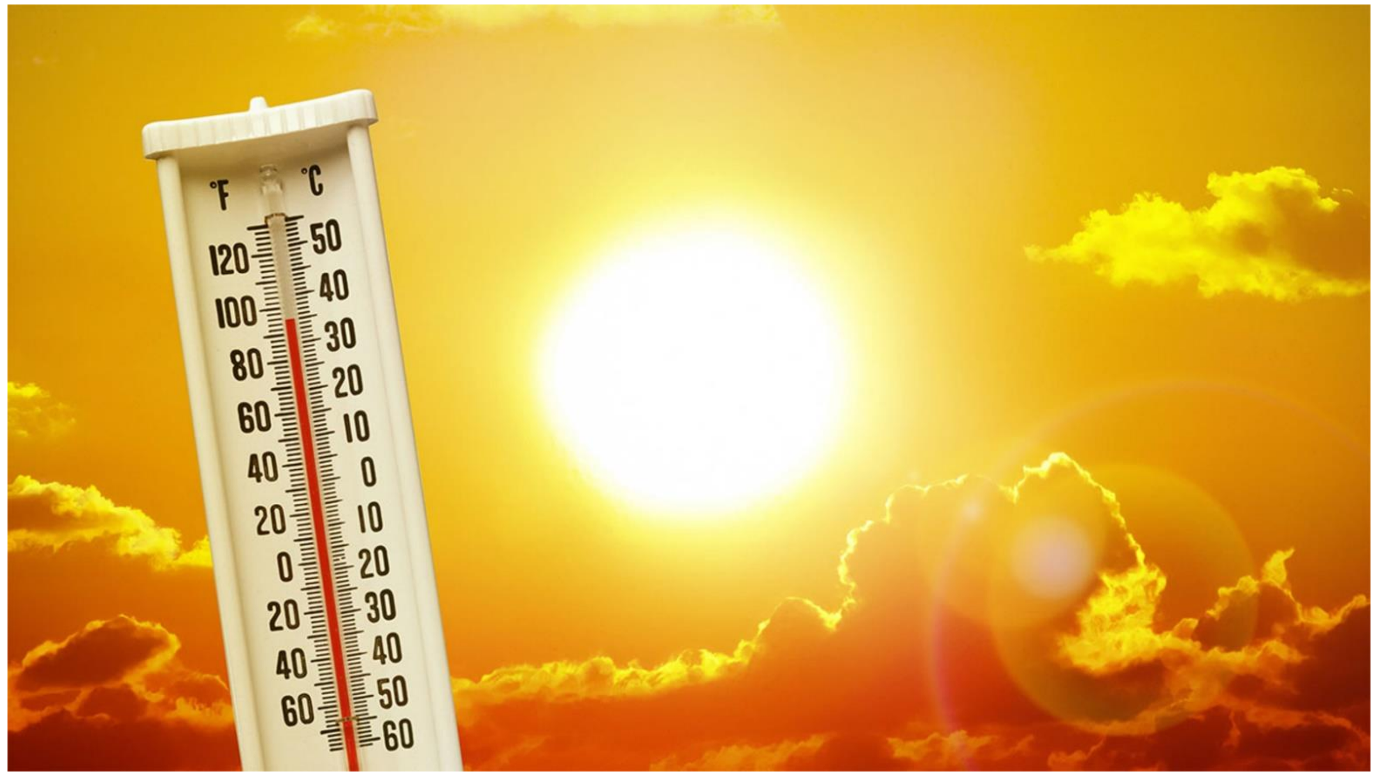


- Positive phases 1924-44, 1977-99
- Negative phases 1870-95, 1911-23, 1945-76, 1999-2015?

- During a negative phase
- SPCZ displaced further southwest during La Niña
- Rainfall generally lower than normal northeast of the SPCZ and in the central equatorial Pacific
- Higher than normal southwest of the SPCZ
- MSLP higher than normal to the west of the dateline and lower than normal to the east of the dateline

(Henley et al., 2015), NOAA ERSST V5 data from https://psl.noaa.gov/data/timeseries/IPOTPI/

Background – Air Temperature



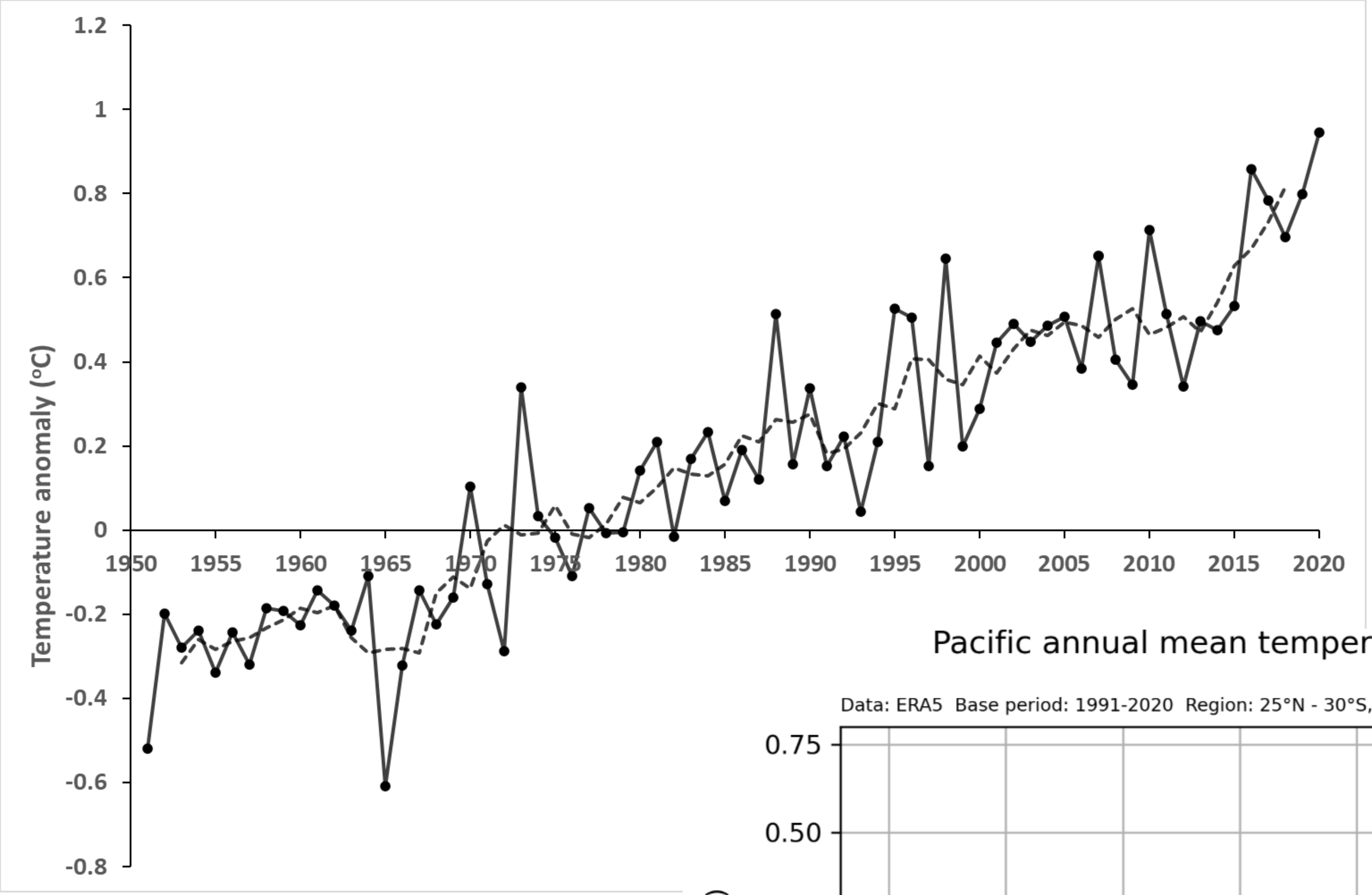
- Important indicator of climate change and variability

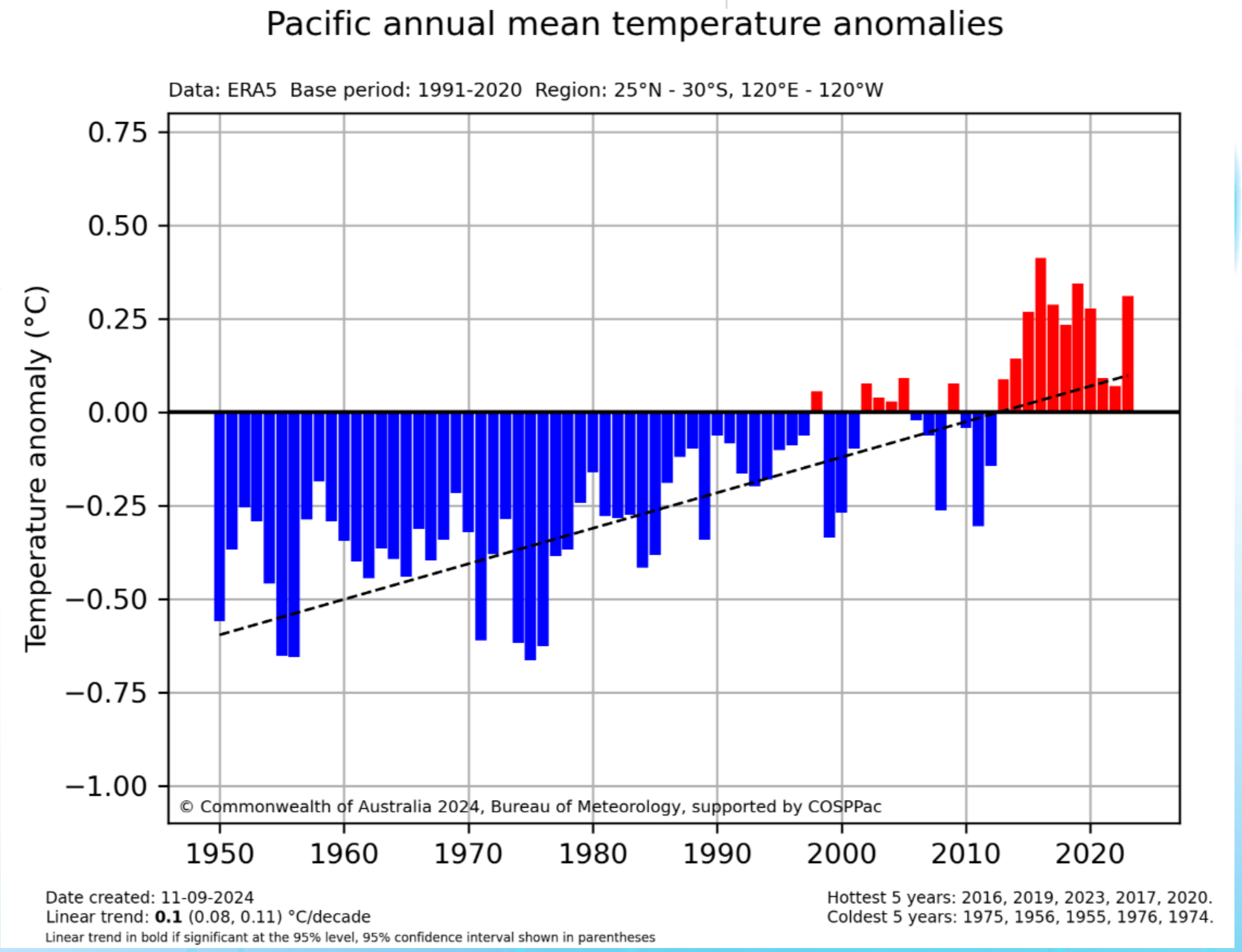
- Higher temperatures tend to be associated with more frequent and intense heat events. Lead to
- Human and animal health issues
- Affect agricultural production
- Increase in energy usages required to maintain indoor comfort
- When combined with clear skies warming temperatures can exacerbate coral bleaching

WMO

PACIFIC REGIONAL CLIMATE CENTRE NETWORK

Trends in annual mean air temperature



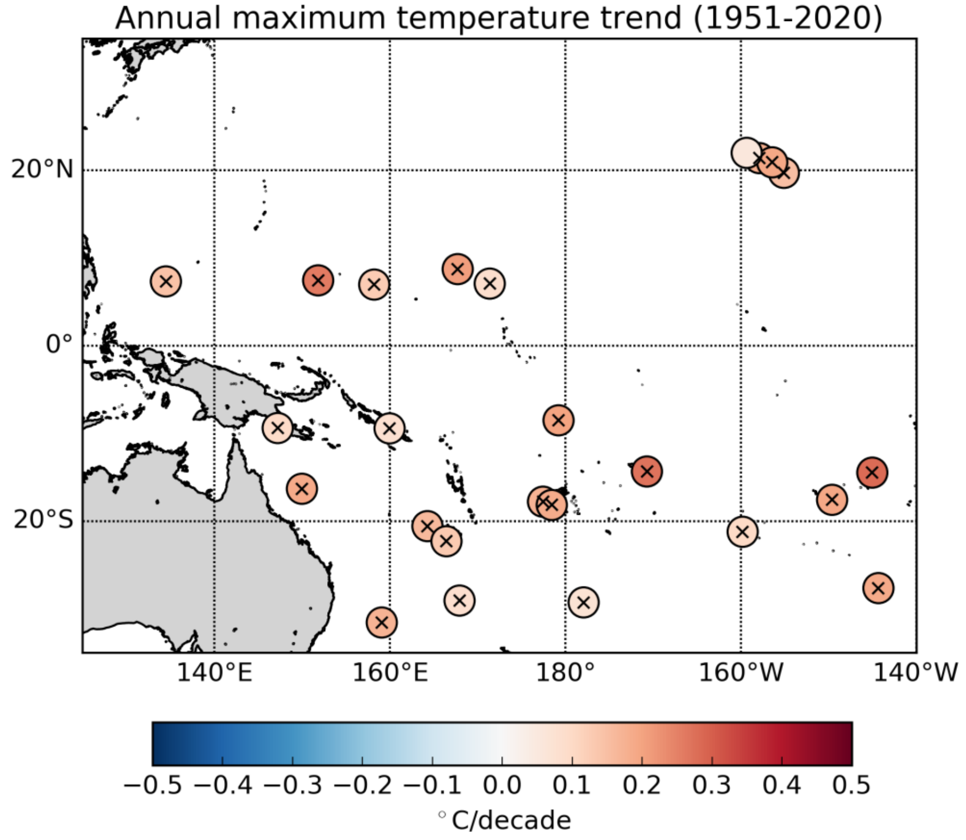


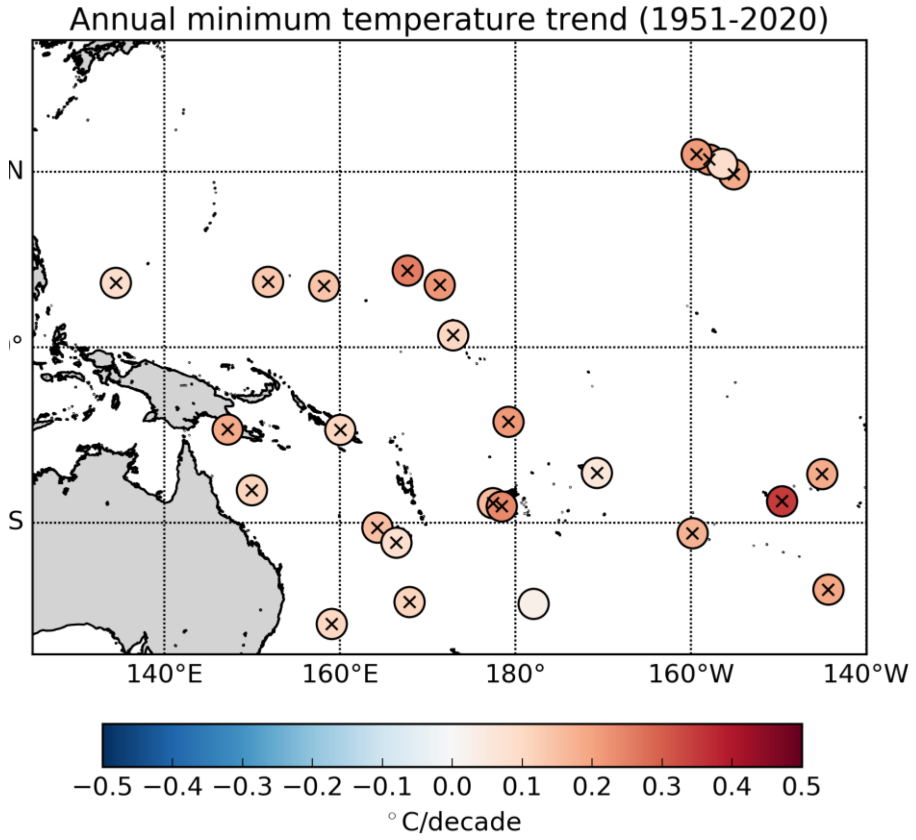
- Land-based annual mean temperature increased by 1.1°C from 1951-2020 (Land + sea, 0.7°C from 1950-2023, ERA5)
- Land based mean temperatures increased over both halves of the 70-year period (1951–1985, 0.5°C [0.9°F] and 1986–2020, 0.6°C [1.1°F]) and in all seasons.
- On a regional scale, over land 2020 was the warmest year on record, 0.9°C (1.6°F) above the 1961–1990 average of 24.9°C (76.8°F).
- Over land, seven of the warmest eight years on record occurred from 2007. Every year since 1983 has been above the 1961–1990 average.

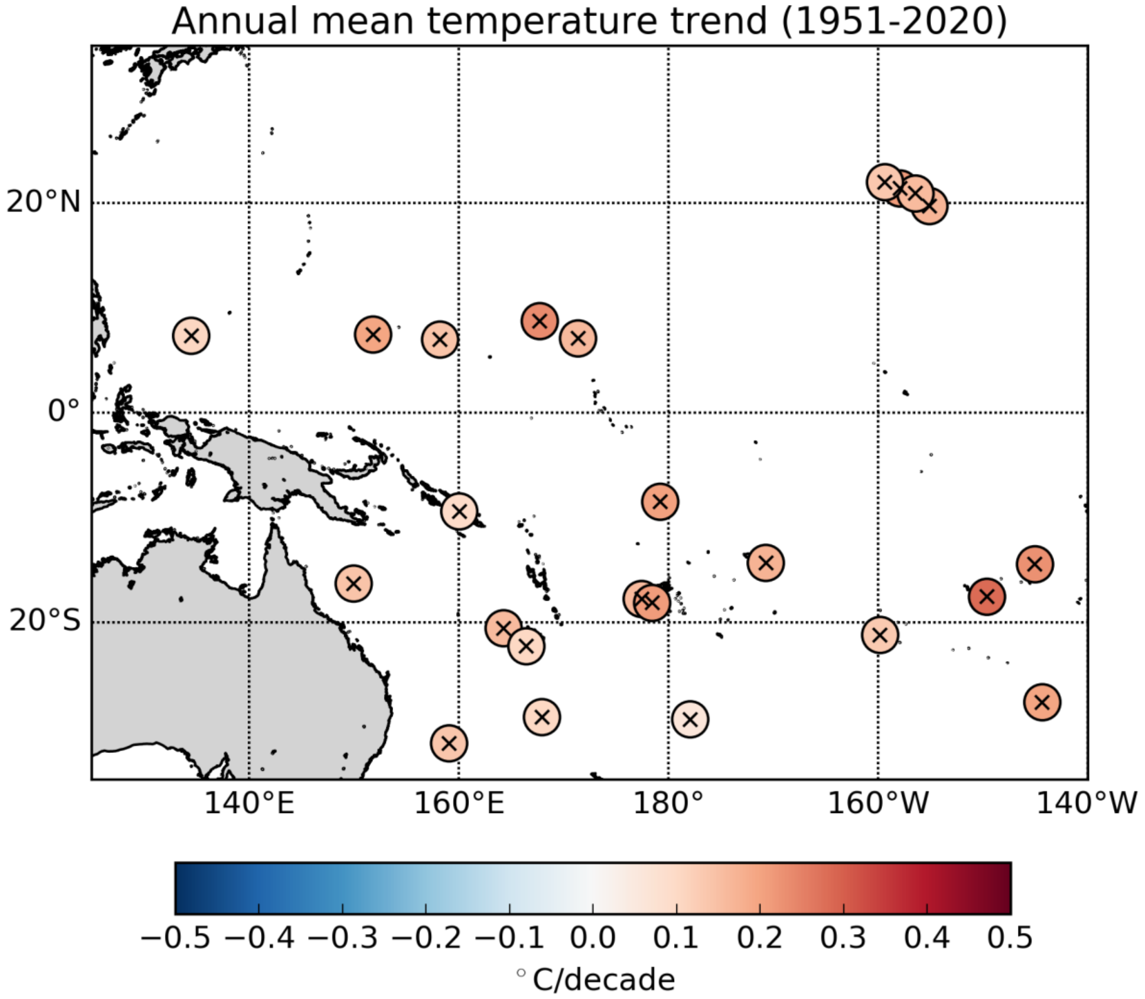
WMO

PACIFIC REGIONAL CLIMATE CENTRE NETWORK

Trends in annual air temperature (1951-2020)

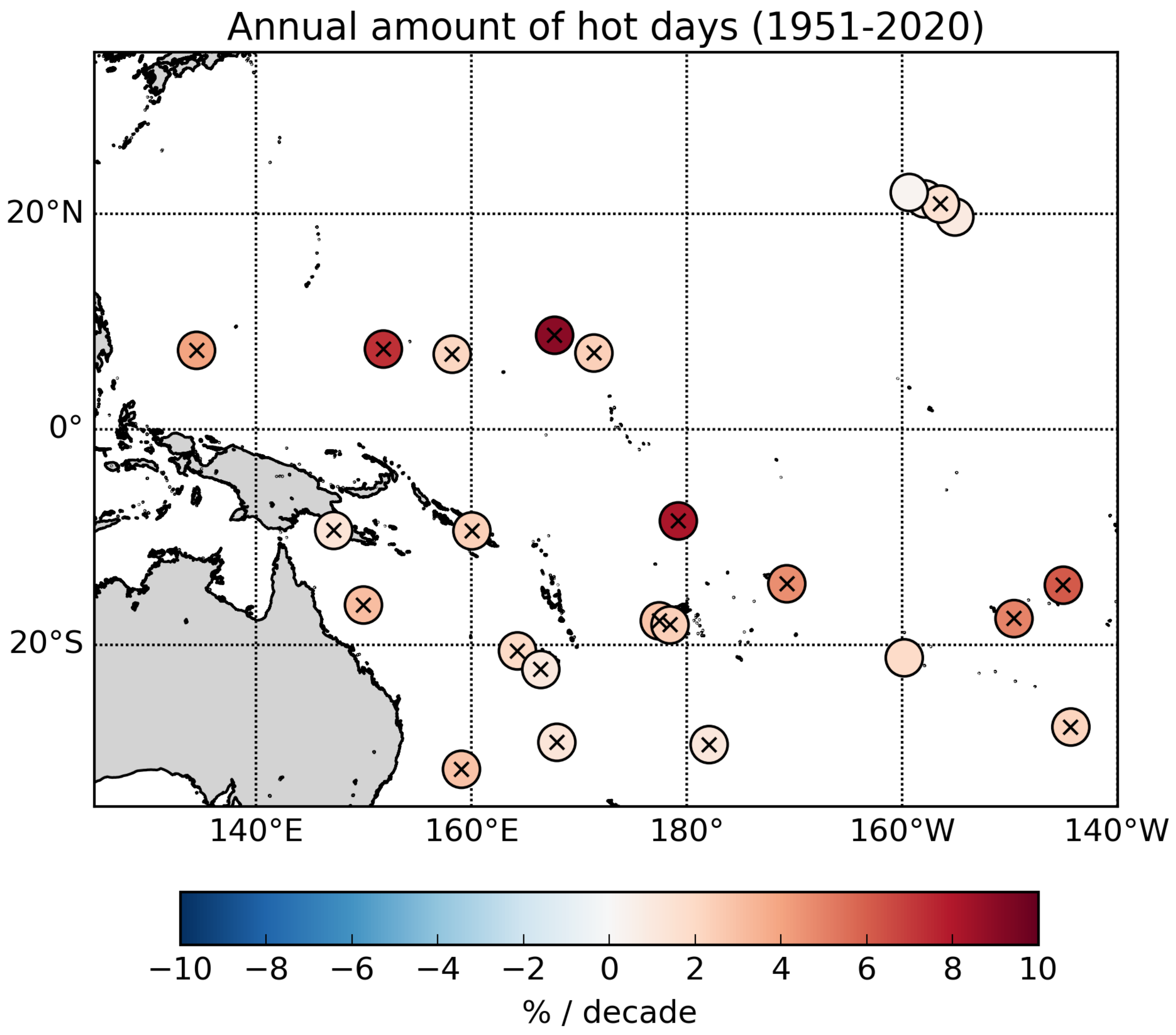






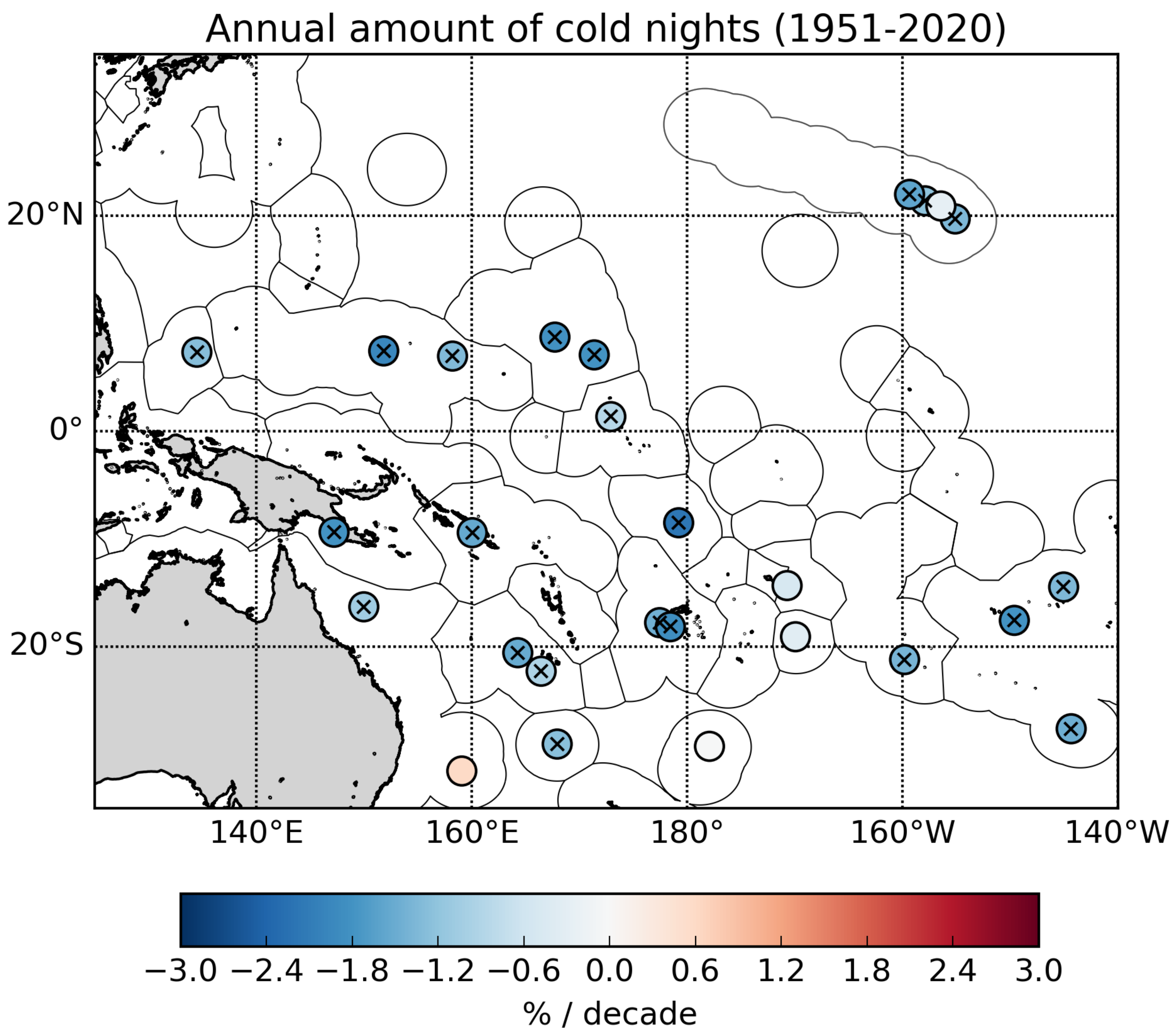
- Daytime maximum and overnight minimum temperatures increases were similar.
- Increases in annual mean temperature occur at all stations, in both hemispheres.
- Trend magnitudes for the period 1951–2020 range from 0.05°C (0.09°F)/decade at Raoul Island in the subtropics of the South Pacific to 0.28°C (0.5°F)/decade at Tahiti-Faaa in French Polynesia.
- Average trend value is about 0.16 °C (0.29°F)/decade.
- Overall, warming in the northern hemisphere (0.17°C/decade) is marginally stronger than that in the southern hemisphere (0.16°C/ decade).
- All site specific annual mean temperature trends are statistically significant at the 95% level

Trends in extreme air temperature (1951-2020)
Indicator: Amount of Hot Days



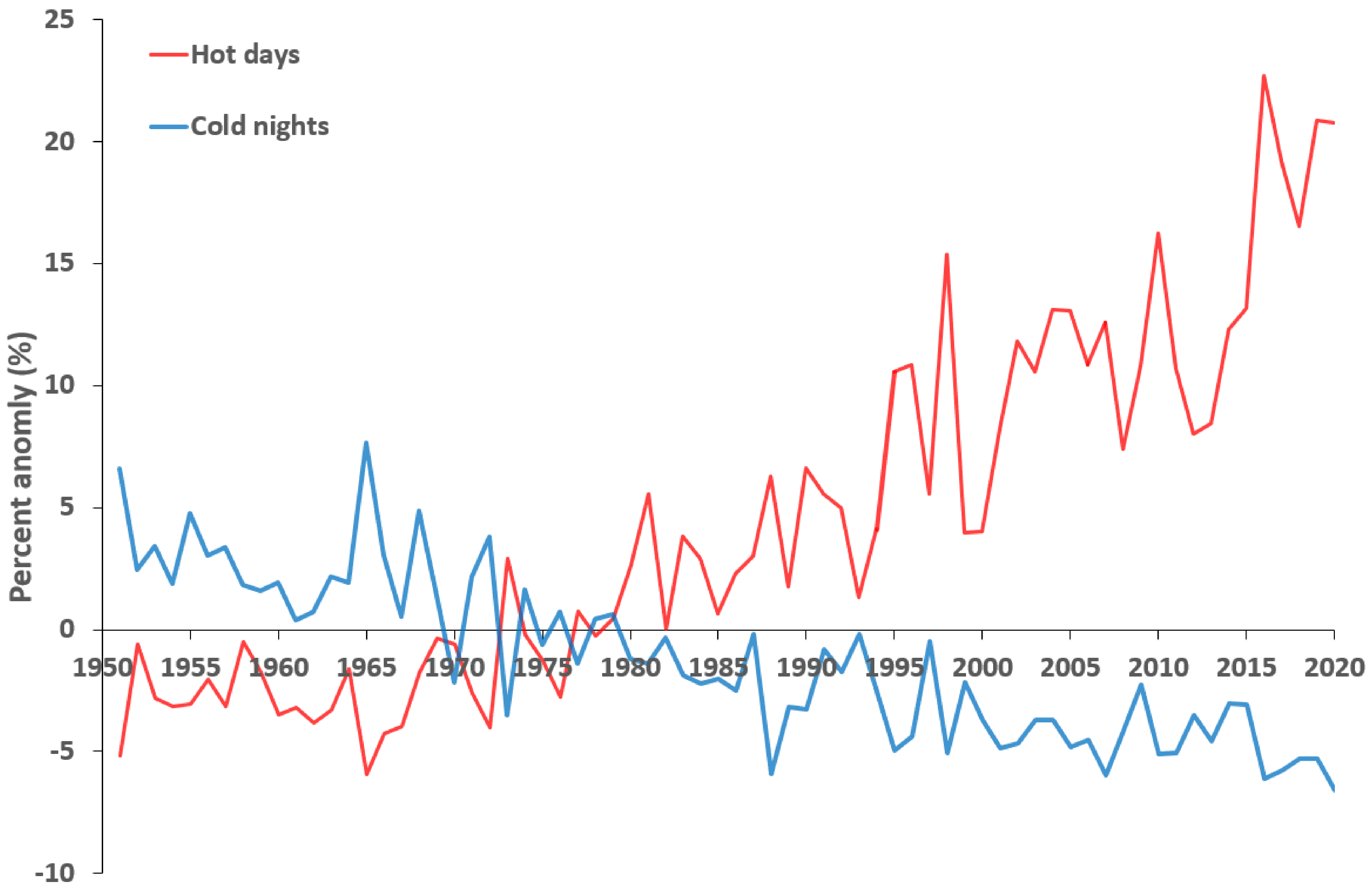
- *Virtually certain* that the number of warm days and nights has increased and the number of cold days and nights has decreased on the global scale since 1950 (Intergovernmental Panel on Climate Change AR6 WG1 report)
- Shift to a warmer climate in the Pacific is accompanied by more extreme daily heat events
- Annual number of hot days has increased at most of the indicator stations. A hot day is defined as a day when the highest temperature is within the highest 10% of observations (for the respective location) between 1961 and 1990
- The regional average change in hot days was 3.1%/decade. At the station level, about 70% of the trend magnitudes were within the 0.7–5.5%/decade range

Trends in extreme air temperature (1951-2020)
Indicator: Amount of Hot Days



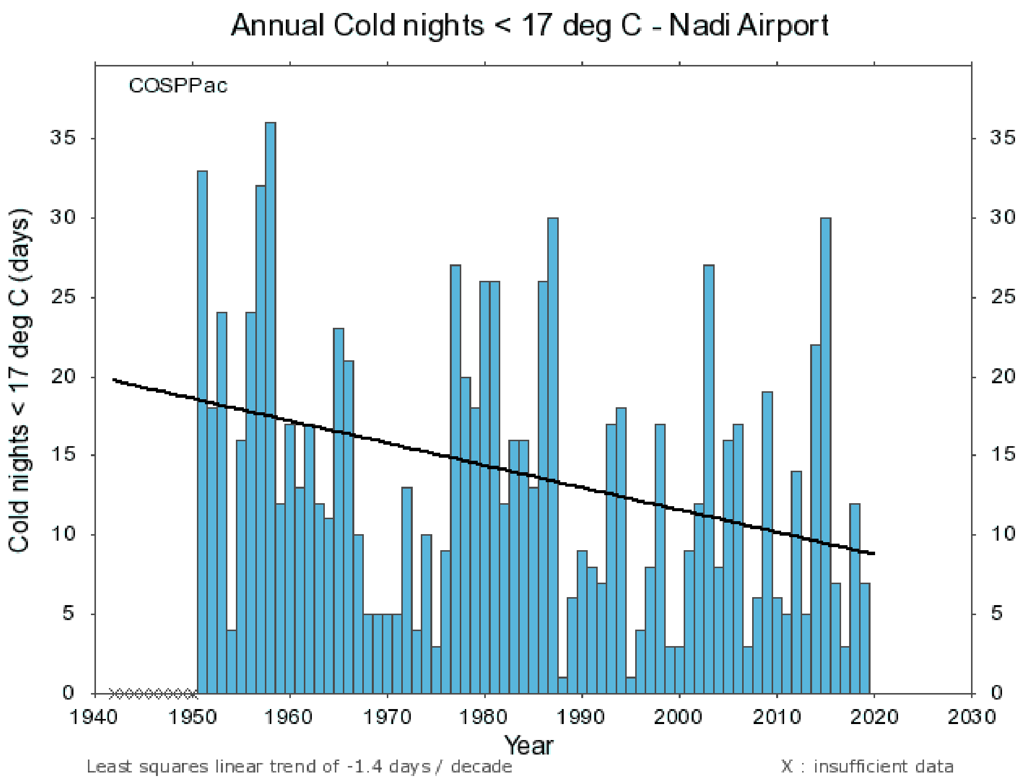
- Shift to a warmer climate in the Pacific is accompanied by fewer cold nights
- Annual amount of cold nights has decreased at most of the indicator stations. A cold night is defined as when the lowest recorded temperature (in a 24-hour period) is within the lowest 10% of observations (for the respective location) between 1961 and 1990.
- The regional average change in cool nights was -1.2%/ decade. At the station level, about 70% of the trend magnitudes were within the -1.9 to -0.6%/decade range

Trends in extreme air temperature (1951-2020)



- Hot days were about three times as common in the 2010s as they were in the 1950s
- A record amount (percentage) of hot days occurred in 2016 (32.3%), which is 22.7% greater than the 1961–1990 average (9.5%).
- Cold nights were about 60% less frequent in the 2010s, compared to the 1950s

Sugarcane in Fiji



- Temperature important in sugarcane production
- Leaf growth constrained with temperatures less than 14-19°C. Photosynthesis is partitioned to sugar accumulation rather than vegetative growth
- Unusually cool 'winters' (June-August) great for sugarcane production in Fiji
- Statistically significant decline in annual cold nights <17°C. Average of 17 days/year over 1950-70. Eleven days/year since 2000.

Summary

- Rainfall has wide ranging impacts on humans and ecosystems across the Pacific Islands. Rainfall supplies drinking water on low-lying atolls, replenishes freshwater lens and provides water for agriculture. Changes in rainfall can disrupt these and other natural processes. Heavy or extreme rainfall can increase of enhance crop damage, soil erosion and floods, reduce quality of drinking water.

- Little change in annual total rainfall at most tropical locations over last 70 years. Drying trends exist in Hawai'i and in the South Pacific subtropics. Consistent with climate change projections.

- Little change in annual and seasonal maximum 1-day rainfall at most locations over the last 70 years.

- The annual consecutive dry days (CDD) index represents change in the longest number of days in year where rainfall is less than 1 mm (0.04 inches). Positive values represent longer periods of low rainfall in recent years. Negative values shorter periods of low rainfall in recent years. There has been little change in annual CDD at most locations over the last 70 years.

- The Interdecadal Pacific Oscillation (IPO) is a measure of decadal variability in the Pacific. Phases can last 20 to 30 years. Positive and negative phases affect the strength and frequency of El Niño and La Niña.

- Currently in a near-neutral-weak negative IPO phase. Negative phases are associated with the SPCZ being displaced further southwest during La Niña. Rainfall generally lower than normal northeast of the SPCZ and in the central equatorial Pacific (Northern Cook Is. Tokelau, Kiribati and Tuvalu). Rainfall higher than normal southwest of the SPCZ (Solomon Is., Vanuatu, Fiji, Tonga).

Summary

- Air temperature is an important indicator of climate change and variability. Higher mean temperatures tend to be associated with more frequent and intense heat events. Higher mean and extreme temperatures led to human and animal health issues and affect agricultural production. Higher temperatures are associated with an increase in energy usage required to maintain indoor comfort.
- Land-based annual mean air temperature increased by 1.1°C between 1951-2020. Over land and sea, the increase was 0.7°C over 1950-2023 (ERA5). At a regional scale, land-based mean temperature increased over both halves of the 70-year period (1951–1985, 0.5°C [0.9°F] and 1986–2020, 0.6°C [1.1°F]) and in all seasons. On a regional scale, 2020 was the warmest year on record, 0.9°C (1.6°F) above the 1961–1990 average of 24.9°C (76.8°F). Seven of the warmest eight years on record occurred from 2007. Every year since 1983 has been above the 1961–1990 average.
- Annual number of hot days has increased at most of the indicator stations in the Pacific Islands. A hot day is defined as a day when the highest temperature is within the highest 10% of observations (for the respective location) between 1961 and 1990.
- Shift to a warmer climate in the Pacific is accompanied by fewer cold nights. Annual amount of cold nights has decreased at most of the indicator stations. A cold night is defined as when the lowest recorded temperature (in a 24-hour period) is within the lowest 10% of observations (for the respective location) between 1961 and 1990.
- Hot days were about three times as common in the 2010s as they were in the 1950s. A record amount (percentage) of hot days occurred in 2016 (32.3%), which is 22.7% greater than the 1961–1990 average (9.5%). Cold nights were about 60% less frequent in the 2010s, compared to the 1950s
- Temperature important in sugarcane production. Leaf growth constrained with temperatures less than 14-19°C. Photosynthesis is partitioned to sugar accumulation rather than vegetative growth. Unusually cool 'winters' (June-August) associated with higher sucrose content in Fiji. Statistically significant decline in annual cold nights <17°C. Average of 17 days/year over 1950-70. Eleven days/year since 2000.

THANK YOU!

simon.mcgree@bom.gov.au