# TEMPERATURE AND THE PACIFIC OCEAN

CLIMATE AND OCEAN

## KEY POINTS

- The ocean stores more heat than the atmosphere and regulates Earth's climate.
- Thermal expansion causes 30–55% of sea level rise, already threatening Pacific islands.
- Ocean temperature drives climate and weather, including storms. Increases in extreme weather events are a threat to Pacific island states.
- Ocean warming threatens key Pacific species, particularly coral reefs, with resulting impacts on human health and livelihoods. The world is presently undergoing a global coral bleaching event driven by elevated ocean temperatures, which has resulted in wide-spread coral mortality.

## HOW ISSUE LINKS TO/IMPACTS SDGs BEYOND SDG14 LIFE BELOW WATER

- SDG1, 2, 3: Poverty reduction, food security and health in the Pacific are threatened by extreme temperatures, particularly due to dependence on local agriculture as well as coastal and reef fisheries.
- SDG5, 10: The impacts of climate change are uneven across gender and location, with impacts more strongly felt by developing nations.
- SDG6: Clean freshwater and sanitation systems are threatened by inundation and salinization, a product of sea level rise which is driven by temperature rise.
- SDG9, 11: Resilient infrastructure for sustainable cities and communities relies on an understanding of, adaptation to, and mitigation of climate change.
- SDG7, 12, 13, 15: Responsible consumption and production, including clean energy and avoidance of degradation of life forms, rely on and are part of climate action.

## BACKGROUND

1. **The ocean has absorbed more than 90% of the extra heat created by human activity.** If the same amount of heat taken up in the upper 2 km of the ocean had gone into the atmosphere, the surface of the Earth would have warmed by 36°C, rather than ~1°C, over the past century. Temperature has increased in the atmosphere (by ~0.6–0.75°C) and ocean (by 0.1°C). The ocean has a higher heat capacity and is much larger, so the warming of the ocean by 0.1°C is 20 times more than the warming of the atmosphere. The increase of hot extremes and decrease of cold extremes affects both land and sea.
2. **There is concern that changes in ocean temperature will change the stratification and circulation of the ocean.** These changes would have broad global impacts. The ocean can be thought of in layers, with warmer, sunlit water at the surface; dark, oxygen-depleted middle waters; and more recently-sunk cold, salty bottom waters with slightly higher oxygen levels (due to recent interaction with the atmosphere) and high nutrient levels. Temperature and salinity drive this stratification (layering), affecting ocean circulation patterns that drive heat exchange and global production.
3. **Warming decreases oxygen levels in seawater, increasing oxygen stress for animals.** The mid-water oxygen minimum zones, created where respiration uses more oxygen than is replaced by photosynthesis (which cannot occur in the dark ocean below ~200 metres), are expanding. There are two main causes: stronger stratification means less oxygen is mixed throughout the water column, and warmer water holds less oxygen.
4. **Ocean heat content and surface current patterns drive weather.** The IPCC reports show that a warming of 2°C above preindustrial average temperature would lead to high risks from extreme weather, including events to which the Pacific islands are particularly exposed, such as cyclones, droughts and floods, and extreme heat waves.

SPREP PROE

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5. **Warmer waters directly affect marine species.** Warming can change where species live and how they grow:
   a. Coral reefs suffer bleaching and disease.
   b. Krill reproduction decreases, disturbing the base of polar ecosystems and limiting the prey of penguins, seals, and whales, among others.[1]
   c. Mobile species that need cooler water may move to higher latitudes, for example, tuna are predicted to move away from the equator,[2] while species that thrive in warmer water will have larger possible ranges.
   d. Some species can become invasive in new locations, outcompeting local species and threatening biodiversity.

   Sea level rise is also a threat to biodiversity, particularly in wetlands, such as salt marshes and mangroves. However, in some locations, sea level rise may help buffer temperature rise as lagoons are more connected to the open ocean.

6. **High temperatures can increase levels of disease or the abundance of harmful organisms**. Harmful algal blooms may increase with higher temperatures and in response to changes in nutrient runoff and coastal salinity with drought or flooding, and the toxicity of HAB organisms may also increase with ocean acidification.[3] Coral diseases and coral bleaching increase in warmer waters. Close to 100% of tropical coral reefs will experience severe bleaching under sustained warming above 1.5°C (IPCC). Changes in reef health will threaten Pacific food security, change shoreline erosion, and more. Sustainable development must take into account future trends to minimise risks.

7. **Marine resources play a significant role in the economic development and culture of Pacific island countries.** Life on Pacific islands is intimately connected to the island and ocean environments. Healthy ecosystems can locally buffer some of the global temperature changes. Well-planned local management and conservation can increase the resilience of island environments and communities to global changes.

1 Hill et al. 2013. Potential climate change effects on the habitat of Antarctic krill in the Weddell Quadrant of the Southern Ocean. PLOS ONE 8:e72246

2 Nicol et al. 2014. Oceanographic characterisation of the Pacific Ocean and potential impact of climate variability on tuna stocks and their fisheries. Pacific Community, Noumea, 10 p

3 Wells et al. 2015. Harmful algal blooms and climate change: learning from the past and present to forecast the future. Harmful Algae 49:68–93