Very fine resolution dynamical downscaling of past and future climates for assessment of climate change impacts on the islands of Oahu and Kauai

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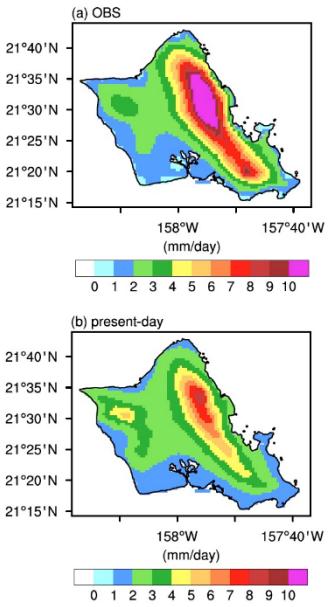
All the main Hawaiian islands including O'ahu and Kaua'i have a wide variety of climates due to topography and location. Photo by Colin Capelle/ CC BY 2.0

Global models for climate simulations tend to have spatial scales that are too coarse to accurately portray island-scale landforms. The variety of valleys and ridges, broad and steep slopes, and land-sea contrasts that give the Hawaiian Islands a diversity of climates despite their relatively small size also complicate modelling efforts. It is necessary to downscale relatively coarse global climate change simulations to high-resolution regional and local predictions of both future mean climate and extreme events. The high spatial resolution of our results means that the projections are relevant for local use by a variety of natural resources agencies, allowing them to better plan for the effects of future climate change.

For our work we further improved and optimized the existing Hawaii Regional Climate Model (HRCM) to better simulate tropical cyclones and other synoptic weather systems as well as large-scale climate features. The HRCM was then used to dynamically downscale relatively coarse climate simulations so that we could better capture the fine-scale climates required to assess possible impacts of global warming on native ecosystems and resource management issues. We also compared two future greenhouse gas emissions scenarios to predict the effects of climate change on the main Hawaiian islands. This type of downscaling is extremely computationally intensive, and our work represents the state of the art in high resolution present-day climate simulations as well as long-term projections of future climate change.

Our projections using a moderate greenhouse gas emissions scenario (RCP 4.5) and a higher greenhouse gas emissions scenario (RCP 8.5) suggest that surface air temperature is projected to increase by the end of the century over the main Hawaiian islands although the effect is more pronounced in the higher greenhouse gas scenario. The increase is slightly greater on the leeward sides of the islands. Rainfall appears to follow the general trend of "wet gets wetter and dry gets drier" with simulated rainfall increasing on windward slopes and decreasing on leeward sides, although over much of the islands' areas the predicted rainfall changes are not statistically significant. However, we also project that heavy rainfall events are likely to become more common as air temperature rises, and it is also likely that tropical cyclones affecting Hawai'i are likely to increase in frequency and strength. Because of the damage and disruption caused by such events it is especially important that decision makers in Hawai'i have detailed information to use in developing adaptation plans and preparing for the effects of changing climate.



Observed (a) and modeled (b) rainfall on O'ahu from 1990 to 2009.

Quick Summary

- A first step in helping prepare society for climate change is to develop predictions of future conditions with sufficient spatial detail to inform decision makers.
- This study produced very high resolution climate projections for the main Hawaiian Islands. These projections include rainfall, air temperature, and tropical cyclone patterns for the end of the century. The results suggest that air temperature and the number of heavy rainfall events are most likely to increase significantly in the future warmer world. Additionally, the number of tropical cyclones in the central North Pacific is likely to increase.
- Climate leaders in the main Hawaiian Islands need to consider the potential for increased numbers of tropical cyclones, along with implications of increased heat stress on public health, infrastructure, and ecosystems, and the increased stress on infrastructure, wastewater, energy consumption, and ecosystems implied by heavy rainfall and hot weather conditions.

PACIFIC ISLANDS CLIMATE SCIENCE CENTER PICSC

This project was supported by the Pacific Islands Climate Science Center (Cooperative Agreement #G13AC00363 from the US Geological Survey). Contact Yuqing Wang (yuqing@hawaii.edu) for more information on this project. To learn more about climate science at PICSC, contact David Helweg at dhelweg@usgs.gov or visit: https://nccwsc.usgs.gov/pacificislandscsc.

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