# In-field temperature data Kane'ohe Bay, O'ahu, Hawai'i from 2013 to 2023

**Website**: https://www.bco-dmo.org/dataset/905047
**Data Type**: Other Field Results, Cruise Results
**Version**: 1
**Version Date**: 2023-07-24

**Project**
» RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)



| Contributors | Affiliation | Role |
|---|---|---|
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**Abstract**
Increasingly frequent marine heatwaves are devastating coral reefs. Corals that survive these extreme events must rapidly recover if they are to withstand subsequent events, and long-term survival in the face of rising ocean temperatures may hinge on recovery capacity and acclimatory gains in heat tolerance over an individual's lifespan. To better understand coral recovery trajectories in the face of successive marine heatwaves, we monitored the responses of bleaching-susceptible and bleaching-resistant individuals of two dominant coral species in Hawai'i, Montipora capitata and Porites compressa, over a decade that included three marine heatwaves. This dataset includes the in situ temperature data from Kāne'ohe Bay, O'ahu, Hawai'i from 2013-2023.

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## Coverage

**Spatial Extent**: **Lat**:21.4509 **Lon**:-157.7954
**Temporal Extent**: 2013-11-28 - 2022-11-28

## Dataset Description

This dataset and other data from this study will be published in the results paper "Divergent bleaching and recovery trajectories in reef-building corals following a decade of successive marine heatwaves." (see pre-print Brown, et al. (2023), doi: 10.1101/2023.07.16.549193).

All BCO-DMO datasets related to this publication can be found on the page https://www.bco-dmo.org/related-resource/915300.

### Methods & Sampling

Location: patch reef 13 in Kāne'ohe Bay, O'ahu, Hawai'i (21.4509, -157.7954)

Study site and temperature data

This study was conducted at Patch Reef 13 (PR13) in the southern end of Kāneʻohe Bay, Oʻahu, Hawaiʻi (21.4509, -157.7954). Hourly seawater temperatures were recorded continuously from January 2014 to April 2023 from temperature sensors within the reef at PR13 (1–2.7 m depth) as well as at two adjacent locations within 0.5 km: (Brown et al., 2022) PR12 (21.45096,-157.7972; 1.5 m depth) and (Rodgers and Jokiel, 2005) the National Oceanic and Atmospheric Administration (NOAA) Pacific Marine Environmental Laboratory (PMEL) 'CRIMP2' buoy (21.458, -157.798; 0.7 m depth) (Brown et al., 2023 Fig. 1, Fig. S1, Table S1). Mean daily (24 hours) seawater temperatures were calculated and averaged when data sources were overlapping, and used to determine cumulative heat stress (degree heating weeks; DHW) at PR13 following the equations in (Brown et al., 2022) (Brown et al., 2023 Fig. 1, Fig. S2, Table S2). The climatic maximum monthly mean (MMM) for Kāneʻohe Bay was determined from seawater temperature data from two monitoring stations on the reefs surrounding the island of Moku o Loʻe (PR1), located approximately 2 km from the study site in the southern region of Kāneʻohe Bay: 1) NOAA's MOKH1 Station (21.433, -157.790; 1.7 m depth) and 2) the HIMB Point Lab Weather Station (21.433, -157.7863; 1 m depth; ((Rodgers and Jokiel, 2005)). Data from 1992–2002 (excluding the 1996 marine heatwave) provided the closest available 10-year data to the time period used by NOAA for determining climatology MMM (1985–1990, 1993), resulting in a climatology MMM for Kāneʻohe Bay of 27.3°C. This MMM was used here to calculate DHW from 2014–2023. Cumulative heat stress at PR13 was compared to PR1 (21.4438, -157.7883; 1 m depth) (Brown et al., 2023 Table S1, Fig. S1). DHWs were also calculated from the temperature data recorded at both PR1 and PR13 using the MMM of 27.0°C (Main Hawaiian Island MMM as determined by NOAA and Kāneʻohe Bay climatology MMM from the 1960s (Jokiel and Coles, 1977)), and other recent MMM values used for Kāneʻohe Bay in the literature: 27.7°C (Wall et al., 2021; Jury and Toonen, 2019) and 28.0°C (Jury and Toonen, 2019; Innis et al., 2021) (Brown et al., 2023 Fig. S2).

### Data Processing Description

See results publication Brown, et al. (2023) for more detailed information on analysis and results.

### BCO-DMO Processing Description

* Table within file "All temperature Kaneohe Bay 2013-2023.csv" was imported into the BCO-DMO data system with values "NA" as missing data values.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.
* DateTime in UTC added to dataset from the DateTime column provided in local time (Hawaii, UTC-10)
* File "All temperature Kaneohe Bay 2013-2023.csv" added as supplemental file.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]
* First column in the data table was un-named column of row numbers. This was removed from the imported dataset.

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## Data Files

| File |
| --- |
| **905047_v1_infield_temp.csv** (Comma Separated Values (.csv), 20.87 MB)<br>MD5:e1ba88d5dfc5f8e5f4720919769d8b24<br><br>Primary data file for dataset ID 905047, version 1 |

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## Supplemental Files

| File |
| --- |
| **Reef 13 temp hotspot through 2023**<br>filename: Reef13 temp hotspot through 2023.csv (Comma Separated Values (.csv), 212.27 KB)<br>MD5:cef8f2ef06a4391b87488e574e53d927<br><br>Degree heating weeks (DHW) table. Reef 13 temp hotspot through 2023.<br><br>Column information:<br>Date,Date<br>N,number of measurements on that day<br>Temperature,Mean temperature, degrees C<br>sd,standard deviation of temperature<br>se,standard error of temperature<br>ci,confidence interval 95% of temperature<br>Hotspot_27.3,if the daily mean temperature exceeded the region's coral bleaching threshold (maximum monthly mean (MMM) + 1°C; 28.3°C);<br>DHW,DHW (degree heating weeks, see methodology) |

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## Related Publications

Brown, K. T., Eyal, G., Dove, S. G., & Barott, K. L. (2023). Fine-scale heterogeneity reveals disproportionate thermal stress and coral mortality in thermally variable reef habitats during a marine heatwave. Coral Reefs, 42(1), 131–142. https://doi.org/10.1007/s00338-022-02328-6
*Methods*

Brown, K. T., Lenz, E. A., Glass, B. H., Kruse, E., McClintock, R., Drury, C., Nelson, C. E., Putnam, H. M., & Barott, K. L. (2023). Divergent recovery trajectories in reef-building corals following a decade of successive marine heatwaves. bioRxiv preprint. https://doi.org/10.1101/2023.07.16.549193
*Results*

Innis, T., Allen-Waller, L., Brown, K. T., Sparagon, W., Carlson, C., Kruse, E., Huffmyer, A. S., Nelson, C. E., Putnam, H. M., & Barott, K. L. (2021). Marine heatwaves depress metabolic activity and impair cellular acid–base homeostasis in reef-building corals regardless of bleaching susceptibility. Global Change Biology, 27(12), 2728–2743. Portico. https://doi.org/10.1111/gcb.15622
*Methods*

Jokiel, P. L., & Coles, S. L. (1977). Effects of temperature on the mortality and growth of Hawaiian reef corals. Marine Biology, 43(3), 201–208. https://doi.org/10.1007/bf00402312 https://doi.org/10.1007/BF00402312
*Methods*

Jury, C. P., & Toonen, R. J. (2019). Adaptive responses and local stressor mitigation drive coral resilience in warmer, more acidic oceans. Proceedings of the Royal Society B: Biological Sciences, 286(1902), 20190614. https://doi.org/10.1098/rspb.2019.0614
*Methods*

Wall, C. B., Ricci, C. A., Wen, A. D., Ledbetter, B. E., Klinger, D. E., Mydlarz, L. D., Gates, R. D., & Putnam, H. M. (2021). Shifting baselines: Physiological legacies contribute to the response of reef corals to frequent heatwaves. Functional Ecology, 35(6), 1366–1378. Portico. https://doi.org/10.1111/1365-2435.13795
*Methods*

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## Related Datasets

**IsRelatedTo**

Rodgers, K. S., P. L. Jokiel, and Western Weather Group, Inc. (2023). HIMB Weather Station: Moku o Loe (Coconut Island), Oahu, Hawaii. [1992-2002] Distributed by the Pacific Islands Ocean Observing System (PacIOOS) (2005) . Distributed by the Pacific Islands Ocean Observing System (PacIOOS). http://pacioos.org/metadata/aws_himb.html.

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## Parameters

| Parameter | Description | Units |
|---|---|---|
| ISO_DateTime_UTC | DateTime (UTC) in ISO 8601 format | unitless |
| Temperature | temperature | degrees C |
| Date | Date (Pacific/Honolulu UTC-10) | unitless |
| Time | Time (Pacific/Honolulu UTC-10) | unitless |
| Site | site name | unitless |
| hour | hour (Pacific/Honolulu UTC-10) | unitless |
| year | year | unitless |
| day | day | unitless |
| month | month | unitless |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | HOBO pendant logger |
| **Generic Instrument Name** | Onset HOBO Pendant Temperature/Light Data Logger |
| **Dataset-specific Description** | Seawater temperature: HOBO pendant logger, NOAA Pacific Marine Environmental Laboratory (PMEL) CRIMP2 buoy |
| **Generic Instrument Description** | The Onset HOBO (model numbers UA-002-64 or UA-001-64) is an in-situ instrument for wet or underwater applications. It supports light intensity, soil temperature, temperature, and water temperature. A two-channel logger with 10-bit resolution can record up to approximately 28,000 combined temperature and light measurements with 64K bytes memory. It has a polypropylene housing case. Uses an optical USB to transmit data. A solar radiation shield is used for measurement in sunlight. Temperature measurement range: -20 deg C to 70 deg C (temperature). Light measurement range: 0 to 320,000 lux. Temperature accuracy: +/- 0.53 deg C from 0 deg C to 50 deg C. Light accuracy: Designed for measurement of relative light levels. Water depth rating: 30 m. |

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## Deployments

**CRIMP2**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/914813 |
| **Platform** | Coral Reef Instrumented Monitoring Platform |
| **Start Date** | 2008-06-01 |
| **Description** | Coral Reef Instrumented Monitoring Platform (21.46°N, 157.80°W). Excerpt from https://www.pmel.noaa.gov/co2/story/CRIMP2 In June 2008 PMEL's carbon group, working with collaborators from the University of Hawaii Department of Oceanography, relocated the CRIMP moored buoy from Southern Kaneohe Bay to a location further north closer to the bay's fringing reef structure and mounted instruments that measure a variety of biogeochemical parameters. These data are used to evaluate the temporal variability in air-sea CO2 fluxes and to assist in examining the mechanisms controlling CO2 fluxes, led by University of Hawaii oceanographer Christopher Sabine. The climate and ecosystem monitoring at this location is supported by NOAA's Coral Reef Conservation Program and Ocean Acidification Program. |

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## Project Information

**RAPID: Collaborative Research: Disentangling the effects of heat stress versus bleaching phenotype on coral performance (Mcap pairs time series)**

**Coverage**: Coral reefs of Kaneohe Bay, Oahu, Hawaii

*NSF Award Abstract:*
Coral bleaching has become increasingly common on reefs worldwide as rising sea surface temperatures associated with climate change disrupt the coral-algal symbiosis. This dramatic heat stress response turns the normally colorful corals bright white, and yet during these heat stress events not all corals undergo bleaching. This project focuses on assessing the effects of bleaching by comparing pairs of corals side-byside on the reef during an ongoing heat wave, where one has bleached and the other has not, despite experiencing the same temperatures. These coral pairs have been monitored throughout three bleaching events in the past five years, providing a unique resource to address whether corals with consistently different bleaching susceptibilities have the capacity to acclimate in response to disturbances through epigenetic changes, or changes in gene expression not due to change in DNA bases. To address this, the project will characterize the impacts of bleaching or not bleaching on coral physiology, gene expression, and epigenetic patterns using coral pairs in their natural habitat during a marine heatwave. This project also provides research support for graduate student trainees, as well as data and materials for the research and training of undergraduate and high school students. This project will recruit underrepresented minority students from URI and UPenn area high schools and university undergraduates for work on computer analysis of images (benthic and colony photographs, brightfield and confocal micrographs) and sequencing data. It will also support the training of an undergraduate student at the University of Hawai'i in coral ecology and physiology, and the development of her senior thesis.

This project will investigate the effects of repeated heat stress events on the performance of Montipora capitata, a dominant reef builder throughout Hawai'i. It utilizes the timely context of paired colonies of M. capitata with bleached vs. unbleached histories that have been monitored through two past bleaching events in Hawai'i (2015 and 2019) and the currently ongoing 2020 event. This system allows for the unique opportunity to disentangle the consequences of heat stress versus bleaching on coral performance through time, an essential feature of reef resilience. The contrasting physiological and energetic processes these two phenotypes undergo during a heatwave are likely to result in alterations to the cellular environment within the animal that impacts epigenetic transcriptional regulation. These regulatory and energetic changes, if persistent over time, have the potential to alter coral fitness beyond the duration of the heatwave differentially between corals with contrasting bleaching phenotypes. Specifically, the project will: 1) quantify the effect of the 2020 heatwave on coral physiology during bleaching and recovery, 2) generate a corresponding archive of coral tissues and nucleic acids as a resource for future work characterizing how bleaching phenotype alters energetics and non-genetic inheritance, and 3) characterize how bleaching phenotype alters intra-generational inheritance of epigenetic marks (i.e., DNA methylation) and gene expression, and the duration of these marks and expression patterns following heat stress. This project represents an urgent assessment of an ideal

system to test the legacy of coral bleaching phenotype on coral fitness. The results of this project will therefore lay the foundation for intra and cross-generational effects of bleaching vs. heat stress, which is essential for understanding coral resilience to climate change.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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## Funding


| Funding Source | Award |
|---|---|
| NSF Division of Ocean Sciences (NSF OCE) | OCE-2102989 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-2103067 |


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