

# Stress band counts from coral cores taken in the central equatorial Pacific

Website: <https://www.bco-dmo.org/dataset/773896>

Data Type: Other Field Results

Version: 1

Version Date: 2019-07-31

## Project

» [Skeletal Records of Coral Reef Bleaching in the Central Equatorial Pacific](#) (Coral Bleaching Skeletal Records)

## Program

» [Paleo Perspectives on Climate Change](#) (P2C2)

| Contributors                       | Affiliation  | Role                      |
|------------------------------------|--|---------------------------|
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## Abstract

Coral cores were collected in the central equatorial Pacific (Central Pacific Coral reefs, -5 to 5 latitude, Dongsha Atoll, Curacao, Barbados, Martinique coral reefs) between March 1982 and June 2015. Stress bands were identified in the CT scan images of each core and quantified.

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## Coverage

**Spatial Extent:** N:6.4 E:-176.6183 S:-4.6779 W:173

**Temporal Extent:** 1982-03 - 2015-06

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## Dataset Description

Coral cores were collected in the central equatorial Pacific (Central Pacific Coral reefs, -5 to 5 latitude, Dongsha Atoll, Curacao, Barbados, Martinique coral reefs) between March 1982 and June 2015. Stress bands were identified in the CT scan images of each core and quantified.

## Acquisition Description

These data were published in Mollica *et al.*, 2019

All cores were collected and analyzed using the same methods. Only live colonies were cored, establishing the top age, vertically i.e., parallel to the upward growth axis, and using either a pneumatic drill fitted with 3-cm diameter diamond tip coring bit or an hydraulic drill fitted with an 8-cm diameter bit. Core holes were sealed with a cement cap and underwater epoxy, secured flush with the colony surface to facilitate overgrowth of tissue and wound closure (e.g. Matson 2011), a 6 to 36-month process depending on the rate of coral growth and diameter of core. All cores were first air dried in the field, then oven dried at 60 °C, and CT scanned intact, together with density standards, on the Siemens Volume Zoom Helical Computerized Tomography (CT) Scanner at Woods Hole Oceanographic Institution or the Siemens Biograph mCT scanner at the Biomedical Research Imaging Center (BRIC) at the University of North Carolina (protocol as per Barkley et al. 2015; DeCarlo et al. 2015).

Location: Central Pacific Coral reefs, -5 to 5 latitude, Dongsha Atoll, Curacao, Barbados, Martinique coral reefs.

## Processing Description

Stress bands and annual growth bands were identified in the CT scan images of each core and quantified using the automated code coralCT for MATLAB which traces the density of individual corallites within the 3 dimensional core (DeCarlo and Cohen 2016). Revisions to version 1.1 of coralCT, which was designed primarily for *Porites* spp., were made to

accommodate the skeletal architecture of the Atlantic corals which have more prominent thecal walls than *Porites*. Specifically, a linear quadratic estimation algorithm (i.e. Kalman Filtering) improved polyp tracing along the core axis. The code was also revised to enable automated identification of stress bands (Barkley et al. 2018). Specifically, the density time-series for all corallites in the core (see DeCarlo et al. 2015, Data Repository Figure DR2) were averaged to create an "ensemble" mean density time series for all traceable corallites. The averaged density profile time-series was then detrended to account for shifts in mean density that may occur over time.

Regions where skeletal density exceeded 2 standard deviations above the whole-core mean, a threshold chosen to account for the range in natural seasonal and inter-annual density variability, were identified as stress bands. To exclude fine-scale density anomalies such as worm borings, stress bands were defined as having a minimum width of 1 mm. Each CT scan was visually inspected to validate the presence and location of stress bands identified by the automated program.

BCO-DMO Processing Notes:

- Modified parameter names to conform with BCO-DMO naming conventions
- converted year/month format to yyyy-mm

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## Related Publications

Barkley, H. C., Cohen, A. L., Golbuu, Y., Starczak, V. R., DeCarlo, T. M., & Shamberger, K. E. F. (2015). Changes in coral reef communities across a natural gradient in seawater pH. *Science Advances*, 1(5), e1500328–e1500328. doi:[10.1126/sciadv.1500328](https://doi.org/10.1126/sciadv.1500328)

Barkley, H. C., Cohen, A. L., Mollica, N. R., Brainard, R. E., Rivera, H. E., DeCarlo, T. M., ... Luu, V. H. (2018). Repeat bleaching of a central Pacific coral reef over the past six decades (1960–2016). *Communications Biology*, 1(1). doi:[10.1038/s42003-018-0183-7](https://doi.org/10.1038/s42003-018-0183-7)

DeCarlo, T. M., & Cohen, A. L. (2016, July 14). Coralct: Software Tool To Analyze Computerized Tomography (Ct) Scans Of Coral Skeletal Cores For Calcification And Bioerosion Rates (Version 1.1). Zenodo. <https://doi.org/10.5281/zenodo.57855>

DeCarlo, T. M., Cohen, A. L., Barkley, H. C., Cobban, Q., Young, C., Shamberger, K. E., ... Golbuu, Y. (2015). Coral macrobioerosion is accelerated by ocean acidification and nutrients. *Geology*, 43(1), 7–10. doi:[10.1130/G36147.1](https://doi.org/10.1130/G36147.1)

Matson, E.G. (2011). Core Plugs. In Hopley, D. (Ed.), *Encyclopedia of Modern Coral Reefs* (pp.294–296) Dordrecht: Springer. DOI:[10.1007/978-90-481-2639-2](https://doi.org/10.1007/978-90-481-2639-2)

Mollica, N. R., Cohen, A. L., Alpert, A. E., Barkley, H. C., Brainard, R. E., Carilli, J. E., ... Young, C. W. (2019). Skeletal records of bleaching reveal different thermal thresholds of Pacific coral reef assemblages. Coral Reefs. doi:[10.1007/s00338-019-01803-x](https://doi.org/10.1007/s00338-019-01803-x)

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## Parameters

| Parameter       | Description                                 | Units           |
|-----------------|---|-----------------|
| Island          | Island of coral sampling                    | unitless        |
| Latitude        | Latitude - south is negative                | decimal degrees |
| Longitude       | Longitude - west is negative                | decimal degrees |
| Stress_Bands    | Stress bands                                | percentage (%)  |
| Number_of_Cores | Number of cores                             | unitless        |
| Year_Month      | Year and month of samples (format: yyyy-mm) | unitless        |

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## Instruments

|   |   |
|---|---|
| <b>Dataset-specific Instrument Name</b> |   |
| <b>Generic Instrument Name</b>          | Computerized Tomography (CT) Scanner  |
| <b>Generic Instrument Description</b>   | A CT scan makes use of computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional (tomographic) images (virtual "slices") of specific areas of a scanned object. |

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## Project Information

## **Skeletal Records of Coral Reef Bleaching in the Central Equatorial Pacific (Coral Bleaching Skeletal Records)**

**Coverage:** Central Equatorial Pacific

NSF abstract: Ocean warming kills corals and efforts are underway to identify and protect coral reefs that may withstand the projected 21st century rise in tropical ocean temperatures. Coral reefs in the central equatorial Pacific (CEP) have been exposed to episodes of extreme warmth every 3-7 years for centuries, if not millennia, yet remain highly productive ecosystems. Initial data obtained by the investigator from stress signatures archived in the skeletons of long lived coral species, suggests that CEP reefs lose their symbiotic algae or bleach, sometimes severely, during warm episodes. The observation that CEP reefs bleach repetitively yet remain productive implies uncommon resilience to ocean warming. The investigator will use laboratory experiments and field observations to validate skeletal records of historical bleaching. A successful outcome will provide novel and valuable insights into the resilience of the CEP reefs and a new tool with which to identify thermally tolerant coral reef ecosystems across the tropics. Additionally, this project includes mentorship of a postdoc and six undergraduate or high school students, outreach through presentations and media, and expansion of publically available software for coral stress band analysis. Ocean warming projections indicate severe impacts to coral reefs will occur on an annual basis within the next few decades.

Consequently, a coordinated effort is underway to identify reefs that might survive these changes. The investigator will test the hypothesis that such reefs exist at the epicenter of influence of the El Niño-Southern Oscillation (ENSO), where strong inter-annual temperature variability creates conditions conducive for the development of thermal resilience. The project uses laboratory-based bleaching experiments and actual stress signatures accreted by wild corals during the 2015 El Niño to validate signatures of historical bleaching archived in the skeletons of massive reef building corals. In addition the investigator will use new, long cores from the CEP to build a robust dataset of historical bleaching back to the 1800's. A successful outcome will increase confidence in the interpretation of skeletal stress bands as quantitative bleaching proxies and enable the reconstruction of the history of coral reef bleaching and recovery in the CEP.

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### **Program Information**

**Paleo Perspectives on Climate Change (P2C2)**

**Website:** <https://www.nsf.gov/pubs/2017/nsf17582/nsf17582.htm>

NSF Synopsis of Program: The goal of research funded under the interdisciplinary P2C2 solicitation is to utilize key geological, chemical, atmospheric (gas in ice cores), and biological records of climate system variability to provide insights into the mechanisms and rate of change that characterized Earth's past climate variability, the sensitivity of Earth's climate system to changes in forcing, and the response of key components of the Earth system to these changes.

Important scientific objectives of P2C2 are to: 1) provide comprehensive paleoclimate data sets that can serve as model test data sets analogous to instrumental observations; and 2) enable transformative syntheses of paleoclimate data and modeling outcomes to understand the response of the longer-term and higher magnitude variability of the climate system that is observed in the geological and cryospheric records.

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## Funding

| Funding Source   | Award                       |
|--|-----------------------------|
| <a href="#">NSF Division of Ocean Sciences (NSF OCE)</a> | <a href="#">OCE-1737311</a> |

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