Bleaching and environmental data for global coral reef sites from 1980-2020

Website: https://www.bco-dmo.org/dataset/773466
Data Type: Other Field Results
Version: 2
Version Date: 2022-10-14

Project
» Identifying coral reef 'bright spots' from the global 2015-2017 thermal-stress event (Coral Reef Brightspots)

Contributors	Affiliation	Role
van Woesik, Robert	Florida Institute of Technology (FIT)	Principal Investigator, Contact
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Abstract
These data include information on the presence and absence of coral bleaching, allowing comparative analyses and the determination of geographical bleaching thresholds, together with site exposure, distance to land, mean turbidity, cyclone frequency, and a suite of sea-surface temperature metrics at the times of survey.

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Coverage

Spatial Extent: **N**:36.75 **E**:179.964472 **S**:-30.2625 **W**:-179.974333
Temporal Extent: 1980-06-15 - 2020-08-15

Methods & Sampling

See Methods of van Woesik and Kratochwill (2022; doi: 10.1038/s41597-022-01121-y)

Briefly, data were collected from seven sources: 1) Reef Check (https://www.reefcheck.org/global-reef-tracker/), (2) Donner et al. (2017), (3) McClanahan et al. (2019), (4) AGRRA (https://www.agrra.org), (5) FRRP (https://ocean.floridamarine.org/FRRP/Home/Reports), (6) Safaie et al. (2018), and (7) Kumagai et al. (2018). Site coordinates were standardized to decimal degrees using Google Earth. Coordinates were compared to ensure a sampling event was not duplicated across multiple data sources. Points were removed if they occurred on land or were more than 1 kilometer from a coral reef. Environmental and site data were added to each site, including reef site exposure, distance to land, mean turbidity, cyclone frequency, and CoRTAD Version 6 environmental data.

Data Processing Description

Data processing:
Data were processed using Microsoft Access 2019, R, and QGIS.

Known problems/issues:
There were few data on coral bleaching before the 1998 bleaching event and most data were collected between 2015 and 2016.

BCO-DMO Processing:
version 1:
(date: 2019-07-18)
- renamed "Latitude Degrees" to "Latitude_Degrees";
- replaced blanks (no data) with "nd";
- removed special characters from place names;
- added "Date2" column with date formatted as yyyymmdd.

version 2:
(date: 2022-10-14)
- created "Date" field from separate year, month, day columns;
- removed commas from: "Ecoregion", "City_Town_Name", "Site_Name";
- replaced commas with semi-colons in: "Sample_Comments", "Site_Comments";
- replaced or removed line breaks (\n, \r,
) and tabs (\t) with spaces in: "Sample_Comments", "Site_Comments";
- replaced or removed non-printing characters;
- reordered fields (moved comments to the end for readability);
- rounded latitude, longitude, and turbidity columns to 4 decimal places;
- rounded all other numeric columns to 2 decimal places.

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Data Files

File
global_bleaching_environmental.csv (Comma Separated Values (.csv), 16.00 MB) MD5:42a6f10a6efa9e6b926d04b86b45a19f Primary data file for dataset ID 773466

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Related Publications

Donner, S. D., Rickbeil, G. J. M., & Heron, S. F. (2017). A new, high-resolution global mass coral bleaching database. PLOS ONE, 12(4), e0175490. https://doi.org/10.1371/journal.pone.0175490
Methods

Donovan, M. K., Burkepile, D. E., Kratochwill, C., Shlesinger, T., Sully, S., Oliver, T. A., Hodgson, G., Freiwald, J., & van Woesik, R. (2021). Local conditions magnify coral loss after marine heatwaves. Science, 372(6545), 977–980. https://doi.org/10.1126/science.abd9464
Results

Florida Reef Resilience Program’s Disturbance Response Monitoring 2005–2020. Unpublished data. Florida Fish and Wildlife Conservation Commission. Environmental Protection Agency cooperative agreement number X7-01D00320-0. https://ocean.floridamarine.org/FRRP/ (2020).
Methods

Hodgson, G. (1999). A Global Assessment of Human Effects on Coral Reefs. Marine Pollution Bulletin, 38(5), 345–355. https://doi.org/10.1016/s0025-326x(99)00002-8 https://doi.org/10.1016/S0025-326X(99)00002-8
Methods

Kumagai, N. H., & Yamano, H. (2018). High-resolution modeling of thermal thresholds and environmental influences on coral bleaching for local and regional reef management. PeerJ, 6, e4382. Portico. https://doi.org/10.7717/peerj.4382
Methods

Marks, K.W. AGRRA Database, version (2018-03). http:www.agrra.org/data-explorer/explore-summary-products/ (2018).
Methods

McClanahan, T. R., Darling, E. S., Maina, J. M., Muthiga, N. A., ’agata, S. D., Jupiter, S. D., Arthur, R., Wilson, S. K., Mangubhai, S., Nand, Y., Ussi, A. M., Humphries, A. T., Patankar, V. J., Guillaume, M. M. M., Keith, S. A., Shedrawi, G., Julius, P., Grimsditch, G., Ndagala, J., & Leblond, J. (2019). Temperature patterns and mechanisms influencing coral bleaching during the 2016 El Niño. Nature Climate Change, 9(11), 845–851. https://doi.org/10.1038/s41558-019-0576-8
Methods

Safaie, A., Silbiger, N. J., McClanahan, T. R., Pawlak, G., Barshis, D. J., Hench, J. L., Rogers, J. S., Williams, G. J., & Davis, K. A. (2018). High frequency temperature variability reduces the risk of coral bleaching. Nature Communications, 9(1). https://doi.org/10.1038/s41467-018-04074-2
Methods

Saha, K., Zhao, X., Zhang, H.-M., Casey, K. S., Zhang, D., Zhang, Y., Baker-Yeboah, S., Relph, J. M., Krishnan, A., & Ryan, T. (2018). *The Coral Reef Temperature Anomaly Database (CoRTAD) Version 6 - Global, 4 km Sea Surface Temperature and Related Thermal Stress Metrics for 1982 to 2019* [Data set]. NOAA National Centers for Environmental Information. https://doi.org/10.25921/FFW7-CS39 https://doi.org/10.25921/ffw7-cs39
Methods

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., Halpern, B. S., Jorge, M. A., Lombana, A., Lourie, S. A., Martin, K. D., McManus, E., Molnar, J., Recchia, C. A., & Robertson, J. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience, 57(7), 573–583. https://doi.org/10.1641/b570707 https://doi.org/10.1641/B570707
Methods

Sully, S., & Woesik, R. (2020). Turbid reefs moderate coral bleaching under climate-related temperature stress. Global Change Biology, 26(3), 1367–1373. Portico. https://doi.org/10.1111/gcb.14948
Results

Sully, S., Burkepile, D. E., Donovan, M. K., Hodgson, G., & van Woesik, R. (2019). A global analysis of coral bleaching over the past two decades. Nature Communications, 10(1). doi:10.1038/s41467-019-09238-2
Results

Veron, J., Stafford-Smith, M., DeVantier, L., & Turak, E. (2015). Overview of distribution patterns of zooxanthellate Scleractinia. Frontiers in Marine Science, 1. doi:10.3389/fmars.2014.00081
Methods

van Woesik, R., & Kratochwill, C. (2022). A global coral-bleaching database, 1980–2020. Scientific Data, 9(1). https://doi.org/10.1038/s41597-022-01121-y
Results

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Related Datasets

Different Version

van Woesik, R., & Kratochwill, C. (2022). A Global Coral-Bleaching Database (GCBD), 1998–2020. figshare. https://doi.org/10.6084/M9.FIGSHARE.C.5314466 https://doi.org/10.6084/m9.figshare.c.5314466

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Parameters

Parameter	Description	Units

Site_ID	Unique identifier for each site	unitless
Sample_ID	Unique identifier for each sampling event	unitless
Data_Source	Source of data set	unitless
Latitude_Degrees	Latitude coordinates (positive vaues = North; negative values = South)	degrees North
Longitude_Degrees	Longitude coordinates (positive values = East; negative values = West)	degrees East
Ocean_Name	The ocean in which the sampling took place	unitless
Reef_ID	Unique identifier from Reef Check data	unitless
Realm_Name	Identification of realm as defined by the Marine Ecoregions of the World (MEOW) Spalding et al. 2007	unitless
Ecoregion_Name	Identification of the Ecoregions (150) as defined by Veron et al	unitless
Country_Name	The country where sampling took place	unitless
State_Island_Province_Name	The state, territory (e.g., Guam) or island group (e.g., Hawaiian Islands) where sampling took place	unitless
City_Town_Name	The region, city, or nearest town, where sampling took place	unitless
Site_Name	The accepted name of the site or the name given by the team that sampled the reef	unitless
Distance_to_Shore	The distance of the sampling site from the nearest land	meters (m)
Exposure	The site's exposure to fetch. Site was considered exposed if it had >20 km of fetch, if there were strong seasonal winds, or if the site faced the prevailing winds. Otherwise, the site was considered sheltered or "sometimes". "Sometimes" refers to a few sites with a >20 km fetch through a narrow geographic window, and therefore we considered that the site was potentially exposed during cyclone seasons.	unitless
Turbidity	Kd490 with a 100-km buffer. Turbidity was considered to be positively related to the diffuse attenuation coefficient of light at the 490 nm wavelength (Kd490), or the rate at which light at 490 nm is attenuated with depth. For example, a Kd490 value of 0.1 m?1 means that light intensity is reduced by one natural-log value within 10 m of water. High values of Kd490, therefore, represent high attenuation and hence high turbidity.	reciprocal meters (m-1)
Cyclone_Frequency	number of cyclone events from 1964 to 2014	unitless
Date_Day	the day of the sampling event	unitless
Date_Month	the month of sampling event	unitless
Date_Year	the year of sampling event	unitless
Depth_m	depth of sampling site	meters (m)
Substrate_Name	type of substrate from Reef Check data	unitless
Percent_Cover	average cover value (percent)	percent
Bleaching_Level	Reef Check data, coral population or coral colony	unitless
Percent_Bleaching	An average of four transect segments (Reef Check) or average of a bleaching code	percent

ClimSST	Climatological sea surface temperature (SST) based on weekly SSTs for the study time frame, created using a harmonics approach	degrees Celsius
Temperature_Kelvin	Temperature in Kelvin	Kelvin
Temperature_Mean	Mean Temperature	degrees Celsius
Temperature_Minimum	Minimum Temperture	degrees Celsius
Temperature_Maximum	Maximum Temperature	degrees Celsius
Temperature_Kelvin_Standard_Deviation	Standard deviation of temperature	Kelvin
Windspeed	Windspeed	meters per hour
SSTA	Sea Surface Temperature Anomaly: weekly SST minus weekly climatological SST	degrees Celsius
SSTA_Standard_Deviation	The Standard Deviation of weekly SST Anomalies over the entire time period	degrees Celsius
SSTA_Mean	The mean SSTA over the entire time period	degrees Celsius
SSTA_Minimum	The minimum SSTA over the entire time period	degrees Celsius
SSTA_Maximum	The maximum SSTA over the entire time period	degrees Celsius
SSTA_Frequency	Sea Surface Temperature Anomaly Frequency: number of times over the previous 52 weeks that SSTA >=1 degree C	SSTA per time period
SSTA_Frequency_Standard_Deviation	The standard deviation of SSTA_Frequency over the entire time period	SSTA per time period
SSTA_FrequencyMax	The maximum SSTA_Frequency over the entire time period	SSTA per time period
SSTA_FrequencyMean	The mean SSTA_Frequency over the entire time period	SSTA per time period
SSTA_DHW	Sea Surface Temperature Degree Heating Weeks: sum of previous 12 weeks when SSTA>=1 degree C	weeks
SSTA_DHW_Standard_Deviation	The standard deviation SSTA_DHW over the entire time period	weeks
SSTA_DHWMax	The maximum SSTA_DHW over the entire time period	weeks
SSTA_DHWMean	The mean SSTA_DHW over the entire time period	weeks
TSA	Thermal Stress Anomaly: Weekly sea surface temperature minus the maximum of weekly climatological sea surface temperature	degrees Celsius
TSA_Standard_Deviation	The standard deviation of TSA over the entire time period	degrees Celsius
TSA_Minimum	The minimum TSA over the entire time period	degrees Celsius
TSA_Maximum	The maximum TSA over the entire time period	degrees Celsius

TSA_Mean	The mean TSA over the entire times period	degrees Celsius
TSA_Frequency	Thermal Stress Anomaly Frequency: number of times over previous 52 weeks that TSA >=1 degree C	TSA per time period
TSA_Frequency_Standard_Deviation	The standard deviation of frequency of thermal stress anomalies over the entire time period	TSA per time period
TSA_FrequencyMax	The maximum TSA_Frequency over the entire time period	TSA per time period
TSA_FrequencyMean	The mean TSA_Frequency over the entire time period	TSA per time period
TSA_DHW	Thermal Stress Anomaly (TSA) Degree Heating Week (DHW): Sum of previous 12 weeks when TSA >=1 degree C	weeks
TSA_DHW_Standard_Deviation	The standard deviation of TSA_DHW over the entire time period	weeks
TSA_DHWMax	The maximum TSA_DHW over the entire time period	weeks
TSA_DHWMean	The mean TSA_DHW over the entire time period	weeks
Date	date of sampling event in format YYYY-MM-DD	unitless
Site_Comments	comments of any issues with the site or additional information	unitless
Sample_Comments	comments of any issue or additional information of sampling event	unitless
Bleaching_Comments	comments of any issue or additional information of bleaching value	unitless

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Project Information

Identifying coral reef 'bright spots' from the global 2015-2017 thermal-stress event (Coral Reef Brightspots)

Coverage: Global

NSF Award Abstract:
Coral reefs are one of the world's most diverse ecosystems that provide goods and services, such as fisheries and storm protection, for inhabitants of tropical and subtropical regions. However, the current rapid rate of climate change threatens the existence of coral reefs as they degrade because of thermal-stress events. Consequently, the coverage and coral composition of many coral reefs is changing. Most global models suggest that few if any reef corals will survive beyond the 2.5 degree Celsius temperature rise predicted for the tropical oceans within the next hundred years. Such predictions differ from recent field studies on coral reefs that show pockets where corals do not bleach and die. The disagreement between the global models and field assessments is a consequence of ignoring climate-change refuges; it is critical to locate the climate-change refuges and determine what circumstances are conducive for coral survival. The investigators will examine the global response of coral reefs to thermal stresses over the last two decades, and focus on the 2015-2017 El Nino event, which caused considerable thermal stress and coral bleaching. The investigators ask the question: Where are the coral reef 'bright spots' from the thermal-stress events? 'Bright spots' are considered as places with less than expected bleaching. The team will also assess why some localities are potential 'bright spots'. Identifying coral reef bright spots will help guide future conservation decisions by

enabling managers to target reefs with specific characteristics, which could be protected from human encroachment and be designated as potential refuges from coral bleaching as climate change progresses. This project includes training of a post-doctoral fellow and a Ph.D student, and host a coral-bleaching workshop. This study will be of relevance to all persons that live and work near coral reefs. What happens to reef corals has cascading consequences on other reef-associated organisms, and also influences whether reefs can keep up with sea-level rise.

The current rapid rate of climate change threatens the existence of coral reefs as they degrade by thermal-stress events. A glimmer of optimism lies in the observation that thermal stresses vary spatially and temporally across the oceans, with the consequence that coral communities in different geographic regions, and under different local conditions, are likely to inherently differ in their capacity to tolerate thermal stress. One of the most transformative aspects of this work is in analyzing the extent to which the bleaching patterns differed from model predictions. This work will capitalize on the recent progress on Bright-Spots Analysis to assess unexpected outcomes. The investigators will take two approaches. First, the project will use a machine-learning algorithm, boosted regression trees to examine the relationships between coral bleaching and the environmental predictor variables of interest. Second, a series of generalized mixed effects models, within a hierarchical Bayesian framework, will be used to identify where geographically 'bright spots' from thermal stress are located and why some coral reefs are more susceptible to thermal stresses than others.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829393

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