

National Coral Reef Monitoring Program Climate Monitoring Brief: Puerto Rico

NOAA/Atlantic Oceanographic & Meteorological Laboratory (AOML) Coral Program

University of Miami Cooperative Institute of Marine and Atmospheric Studies (CIMAS)

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Diver surveying coral reef in La Parguera, Puerto Rico

Mission

The AOML Coral Program tracks the status and trends of coral reef ecosystems in the U.S. Atlantic and Caribbean as part of the National Coral Reef Monitoring Program (NCRMP). This summary brief provides an overview of the most recent climate monitoring efforts in Puerto Rico.

Data collection summary

Subsurface temperature: Subsurface temperature recorders (STRs) were recovered and redeployed at six transects, each one composed of four depths (Fig. 1). In total, more than 10 million temperature observations were collected from 24 instruments (Table 1).

Table 1: Number of temperature observations collected bytransect and depth

Location	1m	5m	15m	25m	Total
Arecibo	105,139	557,457	298,970	568,609	1,530,175
Culebra	364,870	289,966	444,325	391,261	1,490,422
Fajardo	123,562	603,161	241,695	776,035	1,744,453
Jobos Bay	605,123	316,687	622,946	512,922	2,057,678
La Parguera	622,965	513,059	362,198	404,737	1,902,959
Rincon	453,283	286,086	270,786	384,289	1,394,444

NCRMP Climate fixed sentinel site monitoring: At La Parguera - 5m site, located in SW Puerto Rico, short term instruments (54h) were deployed to monitor daily fluctuations in:

- **Current**: 205 observations
- **pH**: 205 observations
- Light: 202 observations
- Carbonate Chemistry: 15 samples collected

Expedition summary

- The NCRMP Atlantic climate monitoring team surveyed in Puerto Rico from May 17th to May 25th, 2023
- A total of 22 different sites were visited by three team members and collaborators, completing a total of 51 dives.



Figure 1: Study sites and depths in Puerto Rico. All study areas have 4 depth points associate.

Habitat persistence: Changes in bioerosion and accretion were monitored:

- **Carbonate budget surveys**: Benthic cover, bioeroding sponge, urchin, and parrotfish surveys completed at six transects
- **Bioerosion**: 60 Bioerosion Monitoring Units (BMUs) collected, 60 redeployed
- **Calcification**: 30 Calcification Accretions Units (CAUs) collected, 30 redeployed

Subsurface temperature

The temperatures that marine organisms experience are a function of local oceanographic conditions and vary with depth. To monitor subsurface temperature, six transects were established around the island. Each transect consists of STRs at four depths (1, 5, 15, 25m; Fig.2). Temperature was measured using SeaBird Electronics Subsurface Temperature Recorders (STR)s that collected data at 5-minute intervals.

The instruments are usually replaced every 3 years for data collection but the COVID - 19 pandemic delayed fieldwork in 2020. Local contractors were hired to refresh the instruments as travel was not allowed. Gaps exist in the data as not all instruments survived the extended deployment time. The full time series of data from 2017 – 2023 at all six locations and all four depths are provided to allow for temporal and spatial comparison of subsurface temperature.



Figure 2: Temperature conditions at six locations in Puerto Rico (Rincon, Arecibo, Jobos Bay, La Parguera, Culebra, Fajardo) representing a depth gradient (1m, 5m, 15m and 25m). Data were collected from June 2017 to July 2023.

Mean temperature values were similar among the locations and depths. Across all sites, the lowest temperatures generally occurred in February (mean: 26.5°C, min: 24.7°C, max: 28.5°C)

Diurnal suite deployment

Seawater carbonate chemistry can fluctuate diurnally, due to biological forcing processes such as photosynthesis and respiration, as well as calcification and dissolution. To characterize this, discrete water samples (Fig. 3) were collected at three-hour intervals (n=15) using Subsurface Automatic Samplers (SAS, www.coral.noaa.gov/accrete/sas).

These samples will be analyzed for Total Alkalinity (TA), Dissolved Inorganic Carbon (DIC), and Spectrophotometric pH

and the highest temperatures in September (mean: 29.4°C, min: 25.4°C, max: 32.1°C).

(Spec pH), which will be used to calculate pCO₂ and aragonite saturation state ($\Omega_{Aragonite}$). A suite of instruments was deployed for a 54-hour period at the La Parguera 5m site. A SeaFET was used to log pH, an EcoPAR measured Photosynthetically Active Radiation (PAR), and a Lowell Tiltmeter measured current speed and direction. Each collected measurements at 15-minute intervals (Fig. 3).



Figure 3: Data from La Parguera diurnal suite monitoring from May 21st to May 23rd, 2023. Top panel: pH and temperature from SeaFET. Bottom panel: Photosynthetically Available Radiation (PAR) and current speed from EcoPAR and Tiltmeter. Shading denotes nighttime throughout sequence of the plot. Instruments measured parameters every 15 minutes.

Habitat persistence

Carbonate budget assessments use transect-based surveys (ReefBudget), to quantify the abundance of carbonate producers (e.g., Corals and crustose coralline algae), and carbonate bioeroders, (e.g., parrotfish and sea urchins). Abundances are multiplied by taxon-specific rates of carbonate alteration to determine if a reef is in a state of net accretion (habitat growth) or net loss (habitat loss; Fig. 4). At

La Parguera, six transects were surveys in 2015, 2017 and 2023 to obtain carbonate budgets. These data show stable carbonate production over the monitoring time points. The transect results showed positive but marginal (< 1kg m² yr ⁻¹) carbonate budgets in 2015, 2017 and 2023, which implies that this site supported low reef accretion over the past eight years.



Figure 4: Net carbonate production and the magnitude of carbonate alteration by calcifying or bioeroding functional groups. PF represents parrotfish. The scale of the y axis varies for each functional group.



Figure 5: New Bioerosion Monitoring Unit deployed at La Parguera, Puerto Rico.

Calcification Accretion Units (CAUs) and **Bioerosion Monitoring Units (BMUs)** were used to investigate the balance between calcification and erosion. CAUs and BMUs were collected and redeployed for the next sampling cycle. CAUs are processed by the NCRMP Pacific Climate group and the data will be available within a year. BMUs will be dried and cleaned using a dilute hydrogen peroxide solution. Samples will be weighed and scanned using a CT scanner and then compared to their pre-scans to quantify bioerosion.

About the monitoring program

AOML's climate monitoring is a key part of the National Coral Reef Monitoring Program of NOAA's Coral Reef Conservation Program (CRCP), providing integrated, consistent, and comparable data across U.S. Managed coral reef ecosystems. NCRMP monitoring efforts aim to:

- Document the status of reef species of ecological and economic importance
- Track and assess changes in reef communities in response to environmental stressors or human activities
- Deliver high–quality data, data products, and tools to the coral reef conservation community

Point of Contact

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For more information

Coral Reef Conservation Program: http://coralreef.noaa.gov NCRMP climate monitoring: https://www.coris.noaa.gov/monitoring/climate.html NOAA Atlantic Oceanographic and Meteorological Laboratory: http://www.aoml.noaa.gov/ Puerto Rico Reef Status Report 2020 National Coral Reef Status Report 2020

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Our Team



Puerto Rico, 2023 Field team with JBNMR staff

AOMLs NCRMP Atlantic and Caribbean Climate

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