# Preaching about Bleaching

## How the oceans have changed

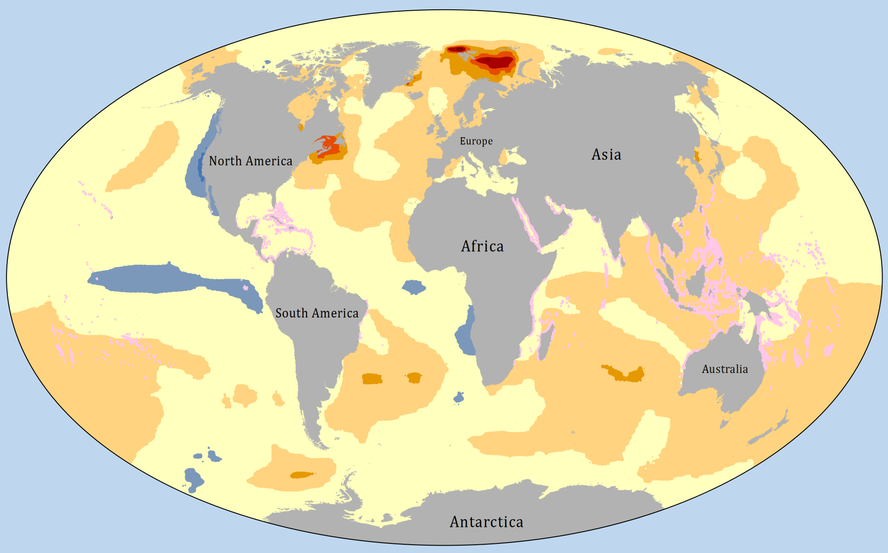
Coral reefs house about 25% of marine species, yet take up a small part of the ocean. These smaller species of fish that live here influence the health of the apex predators. Without corals, biodiversity would decrease. When fish and invertebrates low on the food chain decrease, this causes the apex predators to lose a vital food source. Low biodiversity also causes decline in genetic diversity within the surviving animal populations, which may lead to mutations to propagate and cause mortalities.

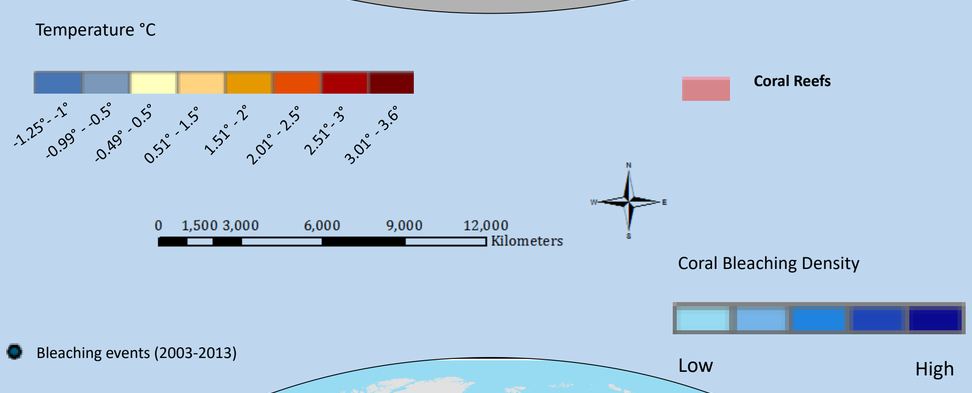
Corals are not in fact plants, but are actually animals or even called a holobiont. A holobiont is actually an entire community of living organisms that make up the coral. These living organisms are simple invertebrates called polyps. Corals are sessile creatures meaning that once they attach to the ocean bottom they do not move. What we see as the coral head, is actually a big group of thousands of polyps together. Another part of the holobiont is the zooxanthellae and bacteria. Zooxanthellae are algae that live within the cells of the coral. Both the bacteria, specifically cyanobacteria and the zooxanthellae conduct photosynthesis to provide energy for the coral.

Aside from providing a great habitat, coral reefs also are very beneficial for humans as well. Coral reefs provide a natural shoreline barrier; this protects humans from the heaviest impacts of natural disasters. When corals are unhealthy this causes a decrease in biodiversity. When there is a decrease in the fish density, this directly impacts the fishing industries. Many commercial fish and shellfish take residence in coral reefs. Over 1 billion people in the world depend on food collected from coral reefs. Another benefit to humans from corals, include the potential for finding natural medicines in such a biodiverse environment. And of course they are beautiful environments that many people travel all over the world to dive in and explore.

Coral bleaching is becoming a more common and serious threat to coral reefs due to climate change and increasing anthropogenic factors. Due to sea surface temperatures, this is stressing the corals. When the corals are stressed this leads to them expelling their zooxanthellae. Once this occurs, this causes the corals to turn white, hence coral bleaching. This does not mean that the corals are dead though. They have the potential to survive and the zooxanthellae can come back. But due to increasing amount of stressors, such as increase in water temperature, increase salinity and ocean acidification just to name a few, the corals are put at higher levels of stress leading to their mortality.

### Change in Temperature 1963-2013




### Density of Coral Bleaching 2003-2013

Figure 2: Graph showing the rise in average global sea surface temperature (https://www.epa.gov/sites/production/files/styles/large/public/2016-07/sea-surface-temp-download1-2016.png)

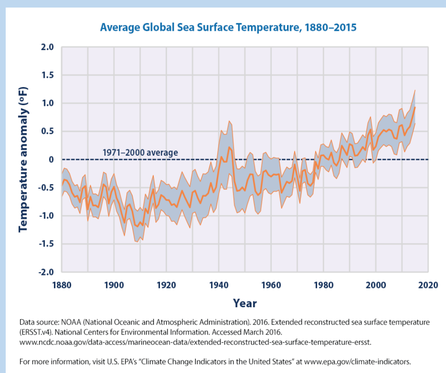
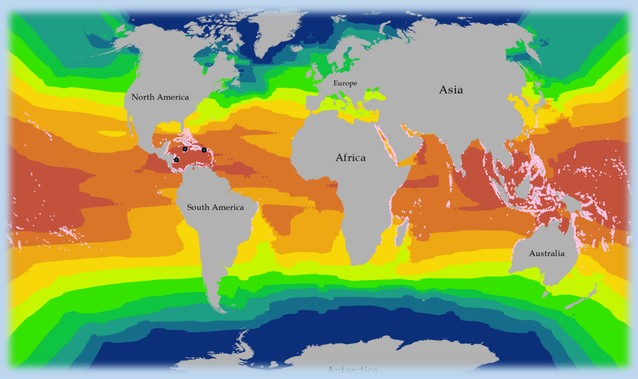


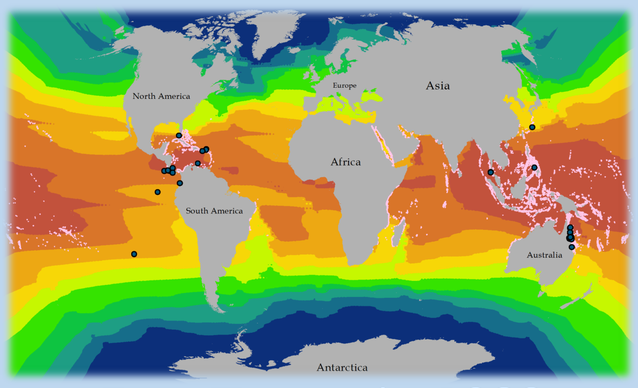


Figure 1: Showing change of coral bleaching over the course of a year from 2014-2015. (https://www.nature.com/polopoly_fs/7.35740.1460545227!/image/4_low_American-Samoa-Before-During-After2.jpg_gen/derivatives/

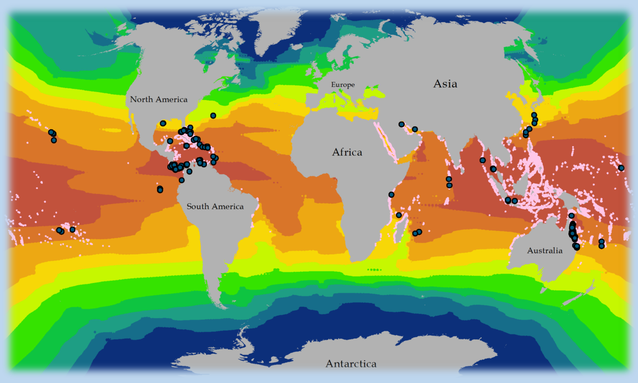
### Avg. Temp. in 1963



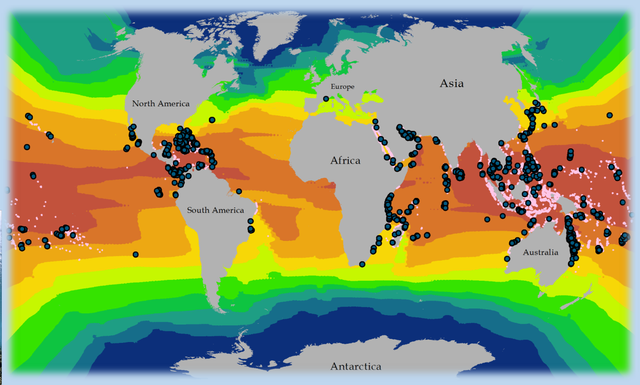

### Avg. Temp. in 1973



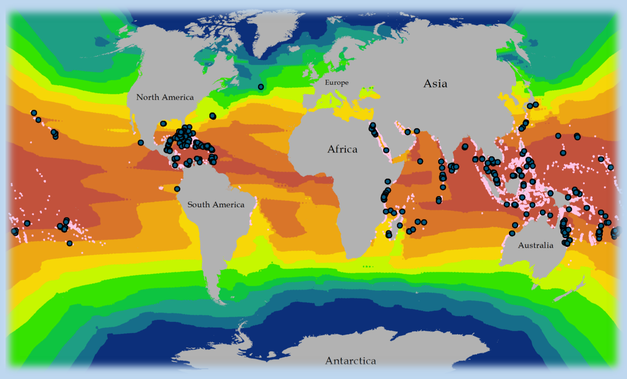

### Avg. Temp. in 1983



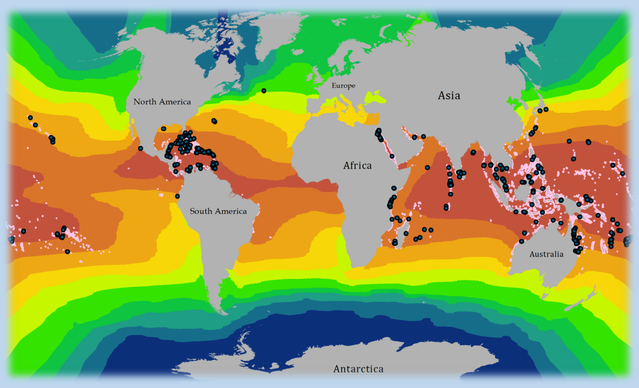

### Avg. Temp. in 1993

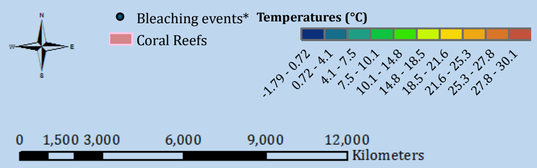



### Avg. Temp. in 2003




### Avg. Temp. in 2013




## Methods

### Temperature maps

- Import in each Net CDF layer for each month in the year.
- Make Net CDF to raster
- Raster Calculator: Every month within the year added up, divided by 12 gives the average temperature per year
- Export raster layer
- Raster to point (batch '63,'73, '83, '93, '03, '13)
- Interpolation: IDW (batch '63,'73, '83, '93, '03, '13)
- Coral bleaching: Select by attributes (1963-1972, 1973-1982, 1983-1992, 1993-2002, 2003-2013) to create new layers

### Coral Density map

- Kernal Density: input bleaching events layer 2003-2013 to find the density of coral bleaching

### Change in Temperature 1960's to 2013

- Raster Calculator: take IDW layers for temperatures in 2013 and subtract the temperatures in 1963.
- Raster to point
- Then use IDW to create a new layer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Data Sources: NOAA, Reefbase, World Resources Institute, ESRI World Projection: World_Winkel_Tripel_NGS

## Is it too hot?

Coral Bleaching events have increased from the 1960's to recent times. Humans have increased their overall our carbon output. Due to this the ocean temperatures have been rising at a rate of 0.13°F per decade, since the beginning of the 20th century. There have been three global bleaching events within the past 54 years. The first major global coral bleaching event was in 1998, and it killed about 16% of the corals around the world. El Niño is a trigger because of how intensely warm the water was and how long it lasted. El Niño is the warm phase of the El Niño Southern Oscillation. The second major bleaching event occurred in 2010. The longest bleaching event ever recorded so far, happened during the third global coral bleaching event in 2015. Naturally these warm and cool phases occur, but due to climate change there are prolonged periods of higher temperatures, increasing the amount of coral bleaching. Global bleaching events are a very important visual indicator of climate change. Further research needs to be conducted considering climate change is not slowing down and these are vital ecosystems.

## Acknowledgements


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