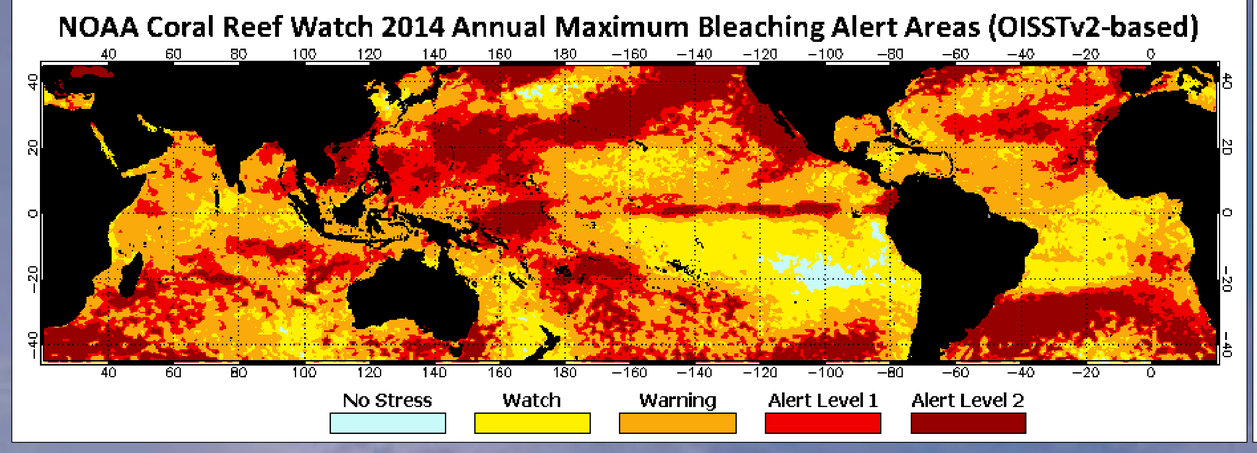
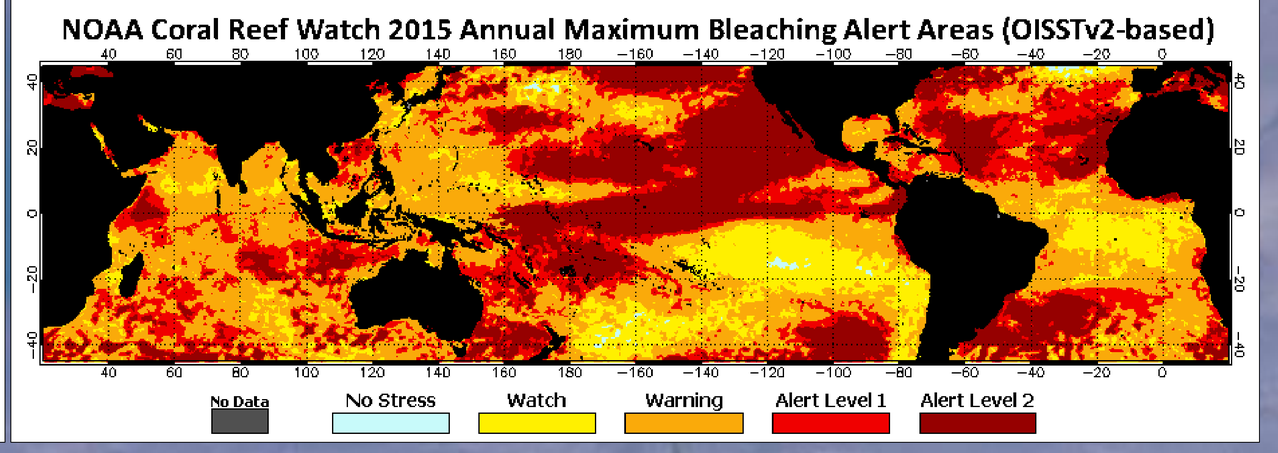
Investigation of Long-Term Change in Global Coral Bleaching Thermal Stress and Identification of Global Bleaching Events Using NOAA 1/4° Daily OISST

Gang Liu[1,2,3], Viva Banzon[4], C. Mark Eakin[1,2], Jacqueline L. De La Cour [1,2,3]

1. Coral Reef Watch, U.S. National Oceanic and Atmospheric Administration (NOAA) , College Park, Maryland (Gang.Liu@noaa.gov); 2. NOAA NESDIS Center for Satellite Applications and Research (STAR), College Park, Maryland;
3. Global Science and Technology, Inc., Greenbelt, Maryland ; 4. NOAA NESDIS National Centers for Environmental Information (NCEI), Asheville, North Carolina (Viva.Banzon@noaa.gov)

The Ongoing Third Global Coral Bleaching Event: 2014-2017?

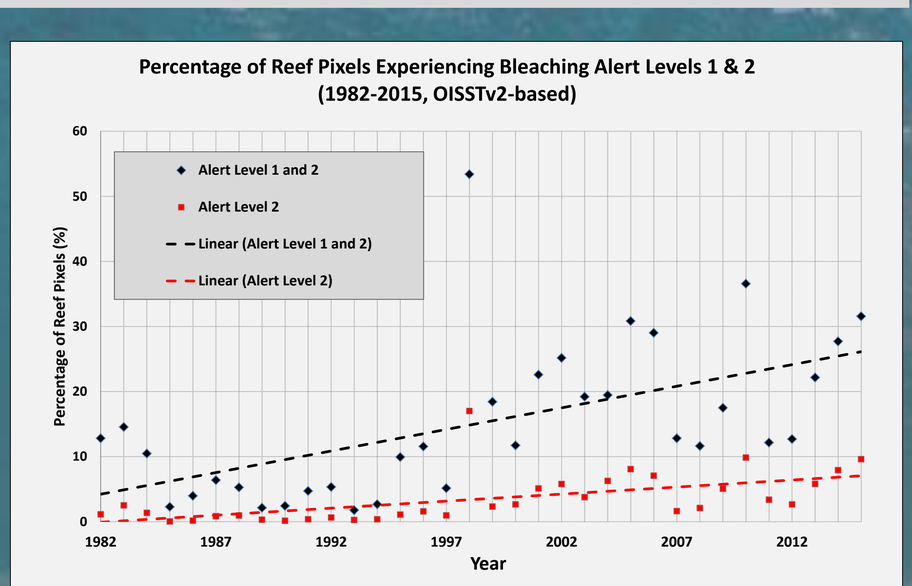




- With the ongoing third global coral bleaching event (2014-2017?) declared by NOAA in October 2015(1), now the longest on record, it is critical to understand how thermal stress that caused mass coral bleaching has changed over recent decades. Previously recorded global events were in 1998 and 2010, with a possible earlier event in 1983(2,3).
- NOAA's 1/4° Daily Optimum Interpolated Sea Surface Temperature (dOISST) Version 2(4) dataset provides a record with sufficient temporal coverage (1982-2016, 34+ years) to investigate long-term changes in thermal stress and identify global bleaching events.

- Using NOAA Coral Reef Watch's satellite coral bleaching thermal stress monitoring algorithm(5,6), increase in bleaching thermal stress was detected globally, but the rate of change varied spatially.
- A linear regression analysis showed that globally, annual percentage of reef-containing dOISST data pixels experiencing high bleaching thermal stress has increased at a rate of about 6.6% per decade during 1982-2015.
- The data also showed that 1983, 1998, 2010, and 2014/2015 are among the extreme years in terms of the percentage of reef pixels affected by high stress levels.

Right: Time series of the 1982-2015 annual percentage of (¼)° reef pixels experiencing severe thermal stress levels and the associated trends. Alert Level 1 can cause significant bleaching while Alert Level 2 can cause widespread bleaching and significant mortality.



Below: 1982-2015 trend of annual maximum coral bleaching thermal stress at global reef locations (compiled by NOAA Coral Reef Watch from various data sources). [Green pixels: small trends (-0.2,0.2) or insignificant (P>0.1) trends].

Algorithm for determining bleaching thermal stress level

Daily Coral Bleaching HotSpot
(SST – SST Bleaching Threshold)

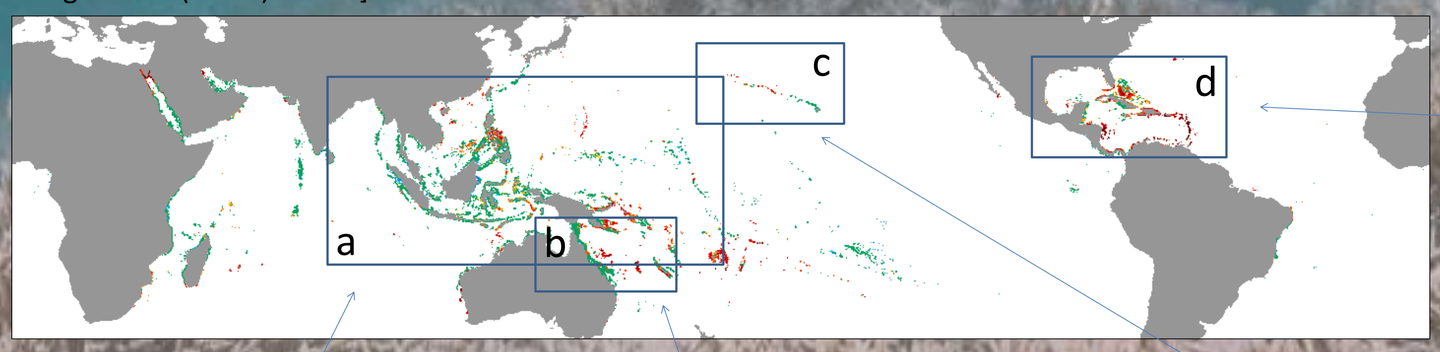
↓

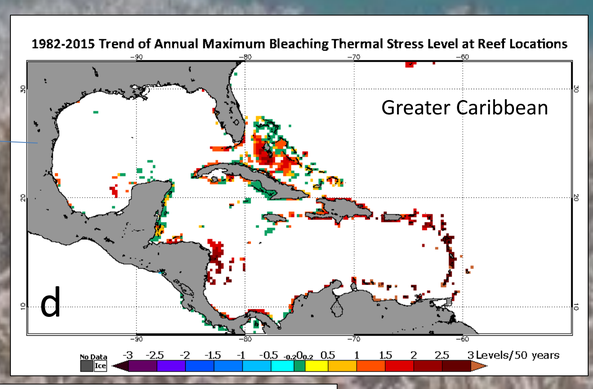
Daily Degree Heating Week (DHW)
(3-month accumulation of daily HotSpots of ≥1°C)

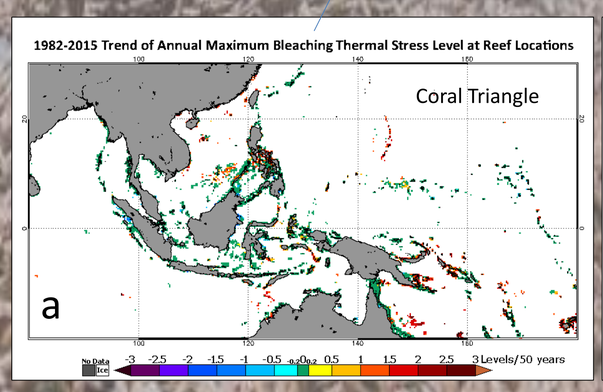
→

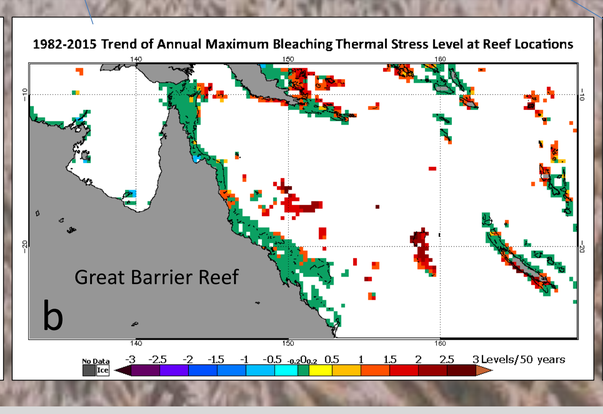
Daily Thermal Stress Level
(based on HotSpot and DHW values)

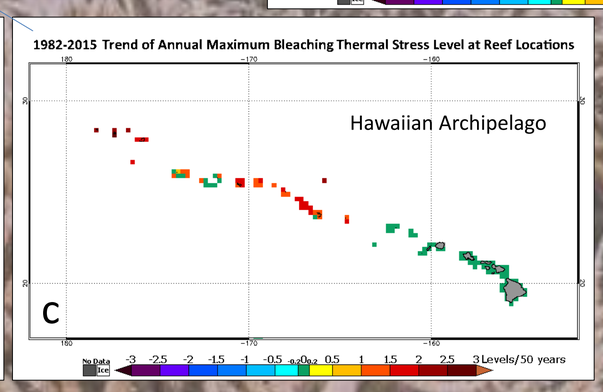
Stress Level	Definition	Potential Bleaching
No Stress	HotSpot≤0	No Bleaching
Bleaching Watch	0<HotSpot<1	
Bleaching Warning	1≤HotSpot & 0<DHW<4	Possible Bleaching
Bleaching Alert Level 1	1≤HotSpot & 4≤DHW<8	Bleaching Likely
Bleaching Alert Level 2	1≤HotSpot & 8≤DHW	Mortality Likely











Below: Bleached plate corals (*Agaricia* sp.) and live sea fans on Molasses Reef, Key Largo, Florida (photo courtesy of Matt Keiffer (Picasa)). Background image: A bleached reef (photo courtesy of XL Catlin Seaview Survey).

- These results will aid future projections, identify vulnerable reef areas, and help develop management response plans for conservation of coral reef ecosystems threatened by ongoing climate change.

References:

1.http://www.noaanews.noaa.gov/stories2015/100815-noaa-declares-third-ever-global-coral-bleaching-event.html.

2.Eakin CM, et al. (2014) Global Coral Bleaching 2014 – 2017: Status and an Appeal for Observations. Reef Encounter 43 31(1): 27-29.

3.Coffroth MA, Lasker HA, Oliver JK (1990) Coral mortality outside of the eastern Pacific during 1982-1983: relationship to El Niño. In: Glynn PW (ed) Global ecological consequences of the 1982-83 El Niño-Southern Oscillation. (Elsevier oceanography series) Elsevier, New York, pp 141-182.

4.Banzon V, et al. (2016) A long term record of blended satellite and in situ sea surface temperature for climate monitoring, modeling and environmental studies. Earth System Science Data, 8, 165-176, doi:10.5194/essd-8-165-2016.

*5.Liu G, et al. (2014) Reef-scale thermal stress monitoring of coral ecosystems: New 5-km global products from NOAA Coral Reef Watch, Remote Sensing, **6** (11): 11579–11606, doi:10.3390/rs61111579.*

6.Liu G, et al. (2013) NOAA Coral Reef Watch 50 km Satellite Sea Surface Temperature-Based Decision Support System for Coral Bleaching Management. NOAA Technical Report NESDIS 143. NOAA/NESDIS. College Park, MD. 33pp.

NOAA Coral Reef Watch and
NOAA National Centers for Environmental Information