GHRSST Coral Heat Stress Task Team Report

written by William Skirving

Task Team Name: Coral Heat Stress User SST Reqirements Task Team

Contributors to current work

Co-Chairs:

William Skirving	University of Reading
Jonathan Mittaz	University of Reading

Task Team Members:

Christopher Merchant	University of Reading
Andrew Norrie	ReefSense
Prasanjit Dash	NOAA
Mark Worsfold	Met Office
Liam Lachs	Newcastle University
Miguel Meis	University of Sao Paulo

Task Team Objectives:

The aim of the GHRSST Coral Heat Stress User SST Requirements Task Team is to help the GHRSST community to understand:

- How users in the marine biological world use SST
- Their needs in terms of what they desire and what they actually need
- Weaknesses in current SST products for use in shallow water
    - Suggestions on how to overcome these weaknesses
    - Testing various SST datasets against physiological responses to heat stress

Major Achievements from 2024 – 2025:

1. Update the Coral Heat Stress User Requirements Document

2. Investigation into the strengths and weaknesses of physical retrieval vs regression-based SST retrieval over coral reefs.
3. Applying metrology methodology to satellite-based coral heat stress monitoring tools.
4. Use of improved SST datasets for Heat Stress Product Production

Update the Coral Heat Stress User Requirements Document

The user requirements document was not updated this year, however we intend to update it over the next 12 months, including a polar section that will address user requirements for sea ice identification.

Investigation into the strengths and weaknesses of physical retrieval vs regression-based SST retrieval over coral:

The Task Team have been slowly investigating if there is a preferred type of SST retrieval algorithm when calculating heat stress over coral reefs. In particular, they have been investigating if there is a difference between regression-based algorithms and physical retrieval algorithms for the calculation of heat stress metrics using satellite SST. To simplify this question, it was decided that ACSPO would be used as a proxy for regression-based algorithms, and CCI would be used as a proxy for physical retrieval algorithms. For this part of the study, two reefs located on opposite sides of the world were chosen as test cases. Each site has in situ temperature loggers against which the satellite SSTs were compared. The two sites were the Dry Tortugas at the Gulf end of the Florida Keys, and Arlington Reef, located in the northern third of the Great Barrier Reef, off the coast of Queensland, Australia.

The results so far, are suggesting that both algorithms can perform equally as well, however ACSPO had an unusually high bias for NOAA-19 day-time SST retrievals, otherwise the algorithms seem to be performing similarly well over coral reefs. This work is ongoing.

The pleasing aspect of this is that CCI is often out performing ACSPO, and when it is not performing as well, the results are close. Based on these preliminary results, there is no reason why CCI would not perform well as a basis from which to calculate heat stress metrics over coral reefs. This is a pleasing result because, while the comparisons were using data from recent years, it is important that the algorithms can provide accurate SST data for the early satellite years (i.e. 1981 onwards), to allow for the creation of appropriate climatologist, against which heat stress is calculated. Due to the lack of reference data, this is hard for a regression-based algorithm to achieve, whereas it is possible with a physical retrieval algorithm.

Applying metrology methodology to satellite-based coral heat stress monitoring tools:

The Task Team have been developing an uncertainty tree for the NOAA Coral Reef Watch satellite-based Degree Heating Week (DHW) product. This activity is somewhat academic; however, it does promise to help the biologists to understand the sources of most uncertainty with respect to their measurements of heat stress. It should also help our understanding of why the DHW product is so very sensitive to SST bias. Prof. Miguel Meis from the University of Sao Paulo is a coral physiologist and has recently joined the Task Team in an effort to improve the biological side of the uncertainty tree. This work is ongoing.

Use of improved SST datasets for heat stress product production:

This activity was designed to demonstrate that although the NOAA Coral Reef Watch (CRW) Degree Heating Week (DHM) algorithm is simple, it is very difficult to implement. We used CCI as an example of a "good quality" SST product that might be used to calculate DHWs, and demonstrated that you do not get the same results to the official DHW product. In fact, you don't even get a result that is able to be calibrated against the CRW version of the DHW (see Figure 1), meaning that it is not only difficult to interpret the DHW calculated using CCI, but its interpretation with respect to the onset of coral bleaching is likely to be highly inaccurate, given that the CRW DHW is considered to be quite accurate.

Expanding the Scope of the Task Team

The task team wishes to expand its scope beyond coral reefs in an effort to cover all marine biota. To facilitate this, we are proposing a new Task Team title of "Marine Heat Stress Task Team". This will allow us to expand our coverage to include use of satellite SST for the study of biological heat stress in temperate and polar regions, with the possibility of opening up new possibilities for funding of the work within this Task Team.

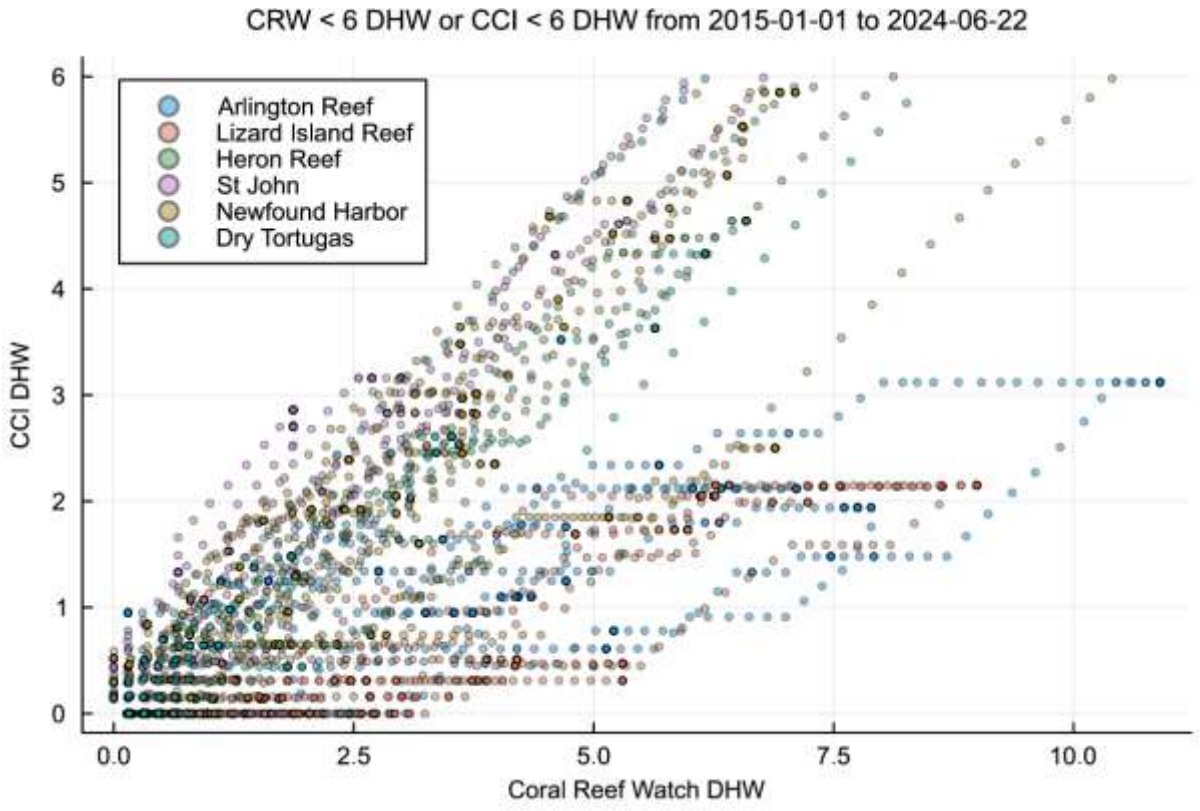

Figure 1: DHW calculated with CCI vs the original Coral Reef Watch DHW product.

Next Steps for 2025 – 2026:

Since all of this work is unfunded, progress is slow, however we expect to make progress on the following topics:

1. Update the Marine Heat Stress User Requirements Document
2. Investigation into the strengths and weaknesses of physical retrieval vs regression-based SST retrieval over coral reefs
3. Applying metrology methodology to satellite-based coral heat stress monitoring tools.