Outline/flow of literature review

* Long-term warming patterns and the overall risk/impact to reefs (500)

(Glynn 1991)

* Old paper about coral bleaching and its links to warming
* Displays the starting point of GBR increasing SST impacts

(Baker et al. 2008)

* Worldwide look at coral reef bleaching
* Using over 25 years of data
* Looks at specific bleaching events around the world
* Before 2007 GBR had had 5 recorded bleaching events (after this paper was written there have been some of the most severe bleaching events on the GBR ever (Hughes et al. 2017).

(Pandolfi et al. 2011)

* Overall trend = warming + OA
* Temp thresholds are species specific and this can also vary geographically
* Mass bleaching have increased in last few decades
* Recovery is variable with some areas not showing substantial recovery after 5-10 years
* Possible projection for future coral reefs
  + Changes to species composition because of species specific reactions
* Suggests that reef degradation due to CC alone will be more heterogeneous than projects suggest now
* Indicates that controlling local factors is the best management strategy to allow reefs to adjust to global changes

(Hughes et al. 2017)

* short term temperature effects == heatwaves, DHD (increased intensity, frequency and longevity) (500)

Ruthrof et al 2018

* heatwaves over bothy marine and terrestrial environments
* coral bleaching and tree mortality at same time

Benthuysen et al 2018

* warming over tropical aus,
* also uses glider extensively
* 2015/16 summer (same as Hughes and Frades papers)
* Also look at long term temperature between 1982 and 2016
* Focuses on strong El Nino as these are often hottest and seam to fit with high level s of coral bleaching

(Hughes et al. 2017)

* direct impact of heating to coral == bleaching and mortality (500)
* include something on coral temperature thresholds

(Hughes et al. 2017)

* hughes closes the door on all of the hopeful thoughts Pandofli 2011
* Recurrent bleaching events – increased severity
* 2016 was the largest and most severe bleaching event on the GBR known
  + >60 of corals bleached
  + Reefs surveyed >90 had some level of bleaching
  + 30% of reefs had between 8-16 DHW
  + Southern part of the reef bleaching was less severe due to local weather conditions (tropical cyclone caused cloud and rain cover which resulted in a 3o drop
  + 32 first time reefs bleached compared to 10 and 9 in 1998 and 2002, respectively
* Only 9% of surveyed reefs have never bleached, 26% bleached once, 35% have bleached twice, 58 second time was 2016 compare to one between 1998/2002 and 29% bleached all three times
* Local factors did not influence bleaching, eg fished or protected zones, water quality but could improve future recovery
* Past bleaching did not have a protective effect for future bleaching
* Severe bleaching is homogenous but at lower severity it can be selective
* Biggest issue is the frequency of severe heatwaves – reefs ith out recent temperature damage are decreasing

(Frade et al. 2018)

* Deep reef refuge/the lack there of during 2015/16 event
  + Will fit well with Hughes paper
* Still 40% bleaching 6% mortality up to 40m depth
* Relative abundance of bleached species
* Depth profile of cumulative exposure (DHD)

the first part will lay out the background information (in detail) and why this work is important to study heatwaves on coral reefs

* Modelling temperature == the types of model, how they were created and validated
  + eReefs (500)

Robson et al 2017 – Evaluating the eReefs model agains observed emergent properties

Not a temperature focused paper but does go into detail about the eReefs model overall

* further eReefs explanations
  + Herzfeld et al 2016
  + Baird et al 2016
  + Chen et al 2013 (vision for eReefs)
  + Car 2013
  + Yu et al 2016
* Earlier eReefs papers
  + Margvelashvili et al., 2003
  + Robson et al., 2006
  + Webster et al., 2006
  + Webster et al., 2003
* eReefs is a process based model, therefore predictions can be made about the process of the features, not just the features
* overall the eReefs models are work well, and in the case of patterns and underlying processes are effective.
* Futher work on process based modelling is encouraged.
* \*compare the trends of temperature profiles for modelled and collected data\*
  + ReefTemp (500)

Maynard (Maynard et al. 2008)

* Created improved models to predict the severity of bleaching events.
* Wanted to improve three factors that reduced the accuracy of DHD on a local scale
  + Temperature is highly variable on reefs locally
    - By increasing the resolution of SST from satellites (to 1-2 km, grid: 0.018o, climatology resolution: 0.042o) using a 14-day mosaic
  + DHD/W is accumulated time (day/weeks) above a temperature threshold but doe not consider the rate of temperature increase. Eg , three weeks at an increase of 1 is the same as a 3 increase for one week, the latter would eb more stressful to organism as there would be a greater phycological toll from the rapid short live increase (much less chance for acclimation.
    - Include a calculation of the heating rate as well as the accumulated days
    - LMST = long-term mean summer temp
  + the max threshold is the same throughout the year
    - the max threshold should vary seasonally
* these were found to improve the accuracy of severity prediction

(Garde et al. 2014) – ReefTemp Next Generation

* the original RT used BOMs 14-day advanced very high-resolution radiometer mosaic of SST

new RT uses daily SST satellite data from IMOS

* + new resolution of 0.02o x
* original RT produced data on SST, SST anomaly, DHD and heating rate.
  + The new RT asl includes: quality level (assess the quality of measurement due to interruptions from cloud cover, gap analysis, single sensor error statistic bias, DHD count, mean positive summer anomaly and grid age using both 1-day IMOS SST and 14-day mosaic SST (Table 2).
  + calibrated with in situ temperature of ocean skin (10-20 um) completed at night to reduce influence of
  + Models used for other reefs (500)
  + Satellite algorithms ??
* Subsurface == SST and sub-surface temperature predictions (1000)

(Castillo & Lima 2010) – very relevant focused on coral reef making zones

* + Question/knowledge gaps
    - Many studies will use satellite data even though bias is well documented
      * How has the eReefs models address the issue of subsurface bias?
* Compared in situ temperatures (at varying depths) with SST derived from satellites
* In coral reefs off southern Belize
* Collected at 2 different reefs (inner lagoon and outer barrier reef), temperature was recorded every 10 to 30 minutes at 3 and 5 m adjacent to corals from June 2002 to December 2007
* Also, temperature recordings every 10 minutes at 1, 3, 6, 9 and 15 between October 2006 and December 2007
* Night and daytime SST from MODIS Aqua and Terra at a resolution of 4km
* Overall the results showed a negative bias for satellite SST and in situ samples, this was consistent between both satellites and locations. Nighttime values had a greater negative bias than day time.
* Used bias (dissimilarity between satellite and in situ), RMSE and Pearson Correlation, also did t-tests of bias between day and night, can also check the with within variance with the bias (want the within to be smaller than the bias), frequency histogram of bias this can be done overall or at different level eg time, location, depth range?
* general trends matched, however:
  + during the day, satellite was higher than recorded (-0.09 to 0.19)
  + during the night, satellite was more than 2°C cooler than in situ measurements (-0.95 to -1.05)
* the correlation was weaker during the night (0.68-0.75) than the day (0.83-0.87)
* thermal stress can affect coral with as little increase as 1 about normal max

(Akbari et al. 2017) – review of sub surface temp modelling but much deep then I will be focused on eg. up to 2000m

* + Effectiveness
  + How others have adjusted these models
  + GAM models + other potential models
* Need to include information on about gliders but unsure where it will fit just yet

the second part leads closer to my research questions: comparing and creating models for the subsurface

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