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COMMENT

Comment on Berkelmans (2002) 'Time-integrated thermal bleaching thresholds of reefs and their variation on the Great Barrier Reef'

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In a paper presenting time-integrated thermal bleaching thresholds for coral reefs (Berkelmans 2002), the author computes bleaching curves at a number of locations on the Great Barrier Reef using an algorithm to interpolate between the warmest non-bleaching year and the coolest bleaching year. His algorithm is represented by:

$$b_c = T_b - s/5(T_b - T_n), \quad \text{for } T_b > T_t$$

where b_c is the predicted bleaching curve, s is the bleaching severity score (integer between 1 and 4), T_b is the temperature distribution curve for the coolest bleaching year (if the temperature data include more than 1 bleaching year), T_n is the temperature distribution curve for the warmest non-bleaching year, and T_t is the threshold temperature (°C). In the legend to Table 1 we are informed that the bleaching severity scores were recorded on a 5 point scale for each location, 1 being the most severe bleaching and 5 the least severe or no bleaching.

A detailed worked up example using the algorithm is shown in Berkelman's Fig. 4 for Kelso Reef (severity score 4). Using this algorithm and the data in the Figure it is not possible to compute the bleaching curve produced by the author. For example, although the algorithm produces a value of about 29.2°C for the 20 d exposure point which is close to the author's own value, the 10 d value of approximately 29.4°C is at variance with Berkelmans' displayed curve point of about 29.7°C.

Examining the bleaching categories and the algorithm more closely, it might be surmised that the author has at some stage mistakenly reversed one or the other. The reason for this is that, as presently represented, an increase in bleaching severity (where s decreases in value) causes the predicted bleaching curve to move closer to the coolest bleaching curve. This is logically the opposite of what should be happening.

To correct this fault I have left the bleaching categories as stated in the paper and examined the effect of reversing the algorithm so that the reference curve is now the warmest non-bleaching year. The algorithm is now represented by:

$$b_c = T_n + s/5(T_b - T_n), \quad \text{for } T_b > T_t$$

Using the author's own example reproduced in Fig. 4 (Kelso Reef: bleaching category 4), and a 'best effort' at reading off a selection of data points, produces the results in Table 1.

Although the reversed algorithm now moves the predicted bleaching curve in the right direction according to the bleaching severity score, it still leaves small dif-

Table 1. Comparison of the bleaching curve obtained with a corrected algorithm to the curve in Fig. 4 of Berkelmans (2002)

y-axis: exposure time (d)	*x*-axis: temperature (°C)					Result
	Warmest non-bleaching year (1999)	Coolest bleaching year (1998)	Difference between 1998 & 1999	Predicted bleaching curve point using corrected algorithm	Actual point from Fig. 4	
20	29.17	29.43	0.26	29.38	29.28	Incorrect
15	29.25	29.65	0.40	29.57	29.52	Incorrect
10	29.33	29.80	0.47	29.71	29.71	Correct
5	29.43	29.91	0.48	29.81	29.88	Incorrect

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ferences for 3 of the selected data points (0.1, 0.05, and 0.07°C).These differences are significant when viewed in the context of the *x*-axis scale (total range 1.6°C, divisions of 0.2°C). Certainly it is not possible for a reader to reproduce the illustrated curves accurately.

This apparent problem is not restricted to the Kelso data. Taking the plot for Wallace Islet (category 4) in Fig. 5, the 1998 curve intercept point appears to be about 30.7°C or greater, whilst the 1997 intercept is about 30.3°C. Using the algorithm the predicted intercept should be about 30.62°C whereas the actual predicted point seems to be 30.5°C. Therefore, the author should re-examine his algorithm and/or bleaching categories and when this is corrected, demonstrate the use of the algorithm in conjunction with actual values to reproduce the curves in Fig. 4.

The importance of this is that the same potential error exists for all the other predicted curves (shown in Fig. 5), and ultimately this will affect the value of the intercept points shown in Fig. 7, where at the moment a relatively weak ($r^2 = 0.44$) latitudinal trend is demonstrated.

The 'reversed' algorithm also produces a slightly unusual result if a bleaching severity score of 5 (no or low bleaching, <1% bleached) is recorded. If the score is awarded because some bleaching was recorded, albeit <1%, then the predicted curve would correspond to the coolest bleaching year curve, and would yield valuable data for the bleaching break point. If, however, the category was scored because no bleaching was observed, then there would by definition be no coolest bleaching year curve (T_b), and the criteria for the algorithm to function would not be satisfied. The author did not have to address this issue in his paper because he recorded no 5 scores but perhaps he would wish to comment further. The problem would not arise if he restricted the category to only very low bleaching (<1%).

LITERATURE CITED

Berkelmans R (2002) Time-integrated thermal bleaching thresholds of reefs and their variation on the Great Barrier Reef. Mar Ecol Prog Ser 229:73–82

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