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## ***Interactive comment on “Ocean acidification limits temperature-induced poleward expansion of coral habitats around Japan” by Y. Yara et al.***

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General Comments:

Whilst I consider this a valuable study, as it seeks to address the influence of both rising sea surface temperatures and declining aragonite saturation state, it paints an overly pessimistic scenario of projected decline of coral habitat in Japan in response to climate change. Although the authors acknowledge the coarse resolution and uncertainty in climatic projections, particularly the negative bias of aragonite saturation state, they do not adequately address and highlight these shortcomings in their projections and discussion.

Moreover, the authors disregard an emerging body of literature which suggests high

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temporal and spatial variability in the responses of corals to climate change (Pandolfi et al., 2011), as exemplified by the responses of coral calcification to temperature (Cooper et al., 2012), the potential for pH up-regulation to counter the effects of ocean acidification (McCulloch et al., 2012a; McCulloch et al., 2012b), and adaptive responses to thermal stress (Guest et al., 2012; Howells et al., 2012). In short the paper deals with coral reefs in a much to physical manner and does not adequately take into account the variable response of species, habitats and geographic localities to climate change. Another example is that corals can thrive very nicely in saturation states less than 3 - see paper by Manzello (his Fig. 3) showing high interspecific variability in calcification rates over natural gradients in  $\Omega_{\text{arag}}$ .

The abstract should be tempered to say that you are only dealing with projections that disregard any role for adaptation or evolution in coral reef organisms, and this should be re-emphasized in the text. This is important, because the papers cited later on at the end of the paper concerning 'adaptation' are not experiments that explicitly tested for the role of adaptation in coral reefs, even though they might assert that there is good reason to discount any role based on the results of their study. It remains true that evolutionary studies are very difficult and time consuming for corals, but it is equally true that our lack of appropriate studies does not mean that evolution and adaptation are not occurring.

The Introduction also paints an overly simplistic view of the potential effects and projections of climate change on coral reefs (see Pandolfi et al. 2011). This is apparent throughout the ms – some examples include lines 8-9, and 16-22 in Section 7176. These are bold statements that ignore the points in the first two paragraphs of this review.

I was also thinking about why the authors combined tropical and subtropical and was wondering how the analysis would have played out had these two habitats been separated the way temperate had been separated. And what about the combined effects of SST and  $\Omega_{\text{arag}}$  – the authors have provided models for the effects of each individ-

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ually, but why not model their combined effects – does the SST up swing swamp the downward trend of  $\Omega_{\text{arag}}$ , or vice versa?

Specific Comments:

Section 7167. It is simply not true that no Pacific coral reef exists in  $\Omega_{\text{arag}}$  of  $< 3$  (also line 24 of section 7169). See papers by Manzello and I think Anne Cohen has done some work on this too. Remember that reefs in high latitudes are already locally adapted to lower  $\Omega_{\text{arag}}$  and this needs to be taken into account when projecting the effects of even lower  $\Omega_{\text{arag}}$  on their ecology. There is also mention of habitat expansion, but surely this also rests on the potential for suitable habitat to be around. Have the authors considered how habitat area might also vary along the Japanese coastline?

Section 7168. Could also cite Greenstein and Pandolfi (2008) here as an example of how this worked in the Pleistocene along the Western Australian coastline.

Section 3.4 The authors point out a number of potential uncertainties in the SST and  $\Omega_{\text{arag}}$  projections, but fail to point out the uncertainties associated with the ecological response of reefs to these projections.

Section 7180 – the authors cite the Anthony et al. 2008 and Diaz-Pulido et al. 2011 papers as examples of test for adaptation in corals, showing them to be poor adaptors, yet these studies did not specifically test for adaptation. Thus the discussion here concerning adaptation is wanting.

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