Response to Anonymous Referee #1

We would like to thank anonymous referee #1 for her/his thoughtful review. Our responses to all of the referee's comments and relevant short comments are italicized below.

The study is an attempt to constrain the variability of surface ocean carbonate chemistry via compiling 3-hourly moored observations for 12 open ocean, coastal, and coral reef locations. Further, these present-day conditions are compared to biologically relevant thresholds associated with ocean acidification.

These are very relevant topics in the context of anthropogenic climate change and definitely within the scope of BG. The paper is detailed and well-written. I would appreciate a more thorough evaluation of state-of-the-art ESMs against this new set of observations, which would be very valuable (as the authors correctly note, ESMs still have issues in capturing the full magnitude of variability), but that is perhaps beyond the scope of this paper.

In the observations-modeling comparisons within this study, our focus was to directly compare seasonal to interannual variability of surface ocean Ωaragonite and pH. This limited our comparison to studies that presented modeling results of these parameters with statistics of annual amplitude and interannual variability (in this case, we presented SD of annual anomalies). The more recent ESM papers the referee mentions focus primarily on trends and lack these types of statistics on seasonal and interannual variability of Ωaragonite and pH. While we did not focus on detection of long-term trends in this paper (because the paired pH observations are not long enough yet to interrogate trends), we do agree that we can make a general evaluation of pre-industrial vs. present day moored observations in the context of these more recent ESM studies that explore time of emergence of OA trends (e.g., Mora et al. 2013, Keller et al. 2014, and Rodgers et al. 2015). We also see that Rodgers et al. (2015) do present SD of linear trends of surface ocean Ωaragonite (Fig A1[b]), which they attribute to the background natural variability (i.e., all temporal variability from sub-seasonal to decadal), so we plan to add a statement about how our open ocean observations compare to the variability presented in that study.

Specific comments:

We agree with making all edits and minor changes brought up by the referee. We respond to the comments that require more detailed responses below.

p 1 line 18: Looking at "long-term change" in the context of "natural variability", wouldn't be the challenge the detectability (and correct estimation) of these long-term trends in OA - which then in turn affect marine life?

Yes, we agree and will clarify that the challenge is in detecting and interpreting long term change in the context of natural variability.

p 2 line 19ff: Please also include more recent studies, e.g., Keller at al., 2014 and Rodgers et al., 2015.

We agree to add a review of and reference to more recent modeling studies relevant to the scope of this study (see above response).

p 3 line 15: "and to ground truth carbonate chemistry variability in earth system models." Quite strong wording for what is actually done later, also considering the small number of locations and (partly quite old) models. Rewrite.

Thank you for pointing this out. We agree to replace this by simply stating this study will compare mooring observations with some past modeling estimates of seasonal to interannual variability of Ωaragonite.

p 7 line +/-25: How exactly do you define overlap? At KEO/Ωarag, the whisker in November seems also to be in the gray.

We identify overlap whenever present day monthly observations within 1.5xIQR (i.e., within whiskers of the box and whisker plots) overlap with pre-industrial range (defined on page 5 lines 21-37). KEO Ωaragonite observations do overlap very slightly with pre-industrial bounds in November and December, and we will add this to the discussion you mention on page 7.