

## Reviewer 2:

I reviewed the original version of this manuscript. I found the paper to be easy to read and given that the paper is a perspective, there was little technical material to evaluate. I have a few suggestions that the authors could consider if they lightly revise the manuscript.

**Response:** We appreciate the constructive comments and positive review.

(1) On line 66, the authors speak to observations that "contain sufficient meaningful information". This seems like a vague and undefined statement. Could you offer some specific examples that help tell the reader what you consider to be "meaningful"?

**Response:** Admittedly information content of observations is an abstract concept. An example of insufficient information content would be comparing the output of a biogeochemical model only to surface chlorophyll observations (or assimilating only surface chlorophyll). This would not be enough to constrain most other state variables and fluxes because the same surface chlorophyll concentration can be achieved by many different combinations of phytoplankton growth and loss rates. A number of examples are given in section 3. We don't want to spell them out with this level of detail in the Introduction because it is supposed to be short and high level, but have modified this sentence as follows (new text in bold):

*"Applications of realistic models rely on them being skillful and accurate, requiring that they include parameterizations of the relevant processes, and that they are constrained by observations that contain sufficient meaningful information (**what is sufficient depends on the application and research question**)."*

(2) Beginning on Line 122: Here, the authors make a seemingly authoritative statement that the direct impacts of OAE on the carbonate system is greatest in the nearfield early in the OAE experiment. Sure, this seems intuitive, but perhaps you could cite literature that supports this statement. Otherwise you could alter the text to reflected that this is an assumption.

**Response:** We are a bit puzzled by this statement because it seems self-evident to us that the biggest impact on the carbonate system is closest to the site of perturbation because mixing and dispersion in the turbulent ocean result in dissipation of the signal away from the perturbation site.

(3) Paragraph on line 418: It might be worth mentioning here that many models in estuaries represent these processes, so I don't think the gap is as big as stated, at least for regional models

**Response:** Two of the authors (Algar and Fennel) work, or have worked, on representing sediment biogeochemical processes in coastal and shelf systems. Both feel strongly that this is indeed a challenge. Again, we are puzzled as to why the statement on line 418, which reads “Representing these processes in coastal and shelf sediments (< 200 m) is challenging.” would be controversial.

(4) Line 669-670: It may be worth pointing out here that one might specifically design an observational program that can fully validate the wide-range of impacts of the particular OAE being applied. Perhaps that is implied, but given that different OAE approaches may have different impacts (metals, injections of particulate material), one can tailor their measurements to track the specific impacts of the specific OAE. If CO<sub>2</sub> drawdown was all that you cared about, chemical measures of the carbonate system would suffice, but if ecosystem effects were important, you might measure everything the authors describe previously.

**Response:** We agree that an observational program should be designed with the specifics of the OAE application in mind and have expanded the text in section 3.3 as follows:

*“As new platforms are added to the observing system, DA techniques can help guide their optimal deployment **and tailor observational programs to the specific needs of OAE applications** (see Section 4.3 below).”*

We also point to section 3.4 dedicated to OSSEs. We feel that talking about this point in section 3.2 “Validation metrics and approach” would be out of place.