Response to Referee #2
"Ocean bubbles under high wind conditions. Part 2: Bubble size distributions and implications for models of bubble dynamics" by Helen Czerski et al., Ocean Sci. Discuss. https://os.copernicus.org/preprints/os-2021-104, 2021
March 2022

We are grateful to the reviewer for their comments and have prepared a revised manuscript which addresses their concerns. Our response to each point and a description of the changes made are given below (reviewer comment in blue, author response in black).

The manuscript reports on a large data set of bubble size distributions at 2m and 4m depth, and in various wind and wave conditions. The data set is extensive and is undoubtedly of interest to the community. The paper merits being published after revisions.

General comments:

I appreciate the difficulty of making such measurements and the dataset is certainly impressive. While I appreciate the honesty of the authors in clearly stating the limitation of the data set, I find the analysis somewhat speculative and lacking, particularly in the use of the ancillary data available from these measurements campaigns.

We are not sure which ancillary data the reviewer is referring to here, but much of it (ADV data, sonar and wave measurements) is discussed in the companion paper. We have added text on line 135 to clarify this point.

It would be interesting to see void fraction and the peaks of the moments of the bubble size distribution, as a function of wind speed, and wave related parameters such as significant wave height, wave age, significant wave slope, and breaking probability (white cap coverage and the like). The data is sufficiently wide that decencies on the sea state are likely to emerge.

The companion paper (which is referenced throughout the text where its results are relevant) is entirely focussed on void fraction measurements and provides a full analysis of that data with respect to wind speed and wave-related parameters. This is mentioned at the end of the Introduction, and in the discussion of the results. We have added text at line 524 to reinforce the point that the discussion and conclusions are based on the data from both papers, and that we are making scientific judgements based on both sets of results. We also note that Appendix C already shows segregation of the data by significant wave height, wind speed, the wind-wave Reynolds number and oxygen saturation, and no notable relationships are seen. We think that the major revisions the reviewer is requesting are all covered in the companion paper and so we have made no amendments to this paper in response to this comment other than reinforcing the references to the other paper.

Minor comments:

Line 68, you mentioned that current numerical models cannot yet reproduce the complexity of breaking and air-entrainment events. I think they are getting pretty close and that's worth mentioning. See Deike et al, JFM 2016 for example. Although it is acknowledged that these numerical models do suffer from the same scale limitations as laboratory experiments do.

We acknowledge the progress represented in the Deike 2016 paper, but that paper is focussed on the total entrained volume of air rather than the details of the bubble processes after entrainment. We have added references to more modelling studies (Deike 2016, Liang 2017) and have made the current progress and limitations clearer. We have also added a note about the lack of field measurements of subsurface flow fields and gas and bubble spatial distributions to validate the assumptions used in those models.

If understand correctly, figure 1a shows the probability of measuring a bubble of a given radius for different wind speeds; and figure 1c shows the radii in the very tail of these distributions in the 90th percentile and up. Does this mean that figure 1c shows bubble sizes that are essentially unlikely to be present in the data (90% of the time)?

This is correct. We have displayed the data in this way because different readers infer different meanings from "maximum bubble radius" – there are always going to be outliers, and we think that presenting the data at a range of percentiles shows where the meaningful cut-off is and allows readers to draw their own conclusions. We think that the 99th percentile is perhaps the most useful for comparison with the turbulence data, ignoring the most extreme outliers but incorporating the bulk of the data. The question here is "what is the largest bubble size that the physical processes allow to be present at this depth?", and so the extreme tail of the distribution is relevant. We have added text to clarify that Figure 1(c) shows data relevant to the tail of the distributions in Figure 1(a).

For clarity, please use the same labels for the normalized size distributions of figures 2b, 3, and 4. Also, it is important to note that the normalization does not render the data dimensionless.

We have re-made the figures with consistent y-axis labels, including the dimensions for the normalised data. We have also modified the captions to match.

Please, rephrase line 275 "At 2 m, the peak volume has a limited relationship with the void fraction, and does not show a large decrease immediately after a peak." I believe the authors meant to say something akin to "At 2 m, the radius of peak volume has a weak relationship with the void fraction, and does not show a large decrease immediately after a large void fraction events"

We have amended the text as suggested.