Ocean Science Discussions

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Comment on os-2021-103; "Flux and Presence"

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Community comment on "Ocean bubbles under high wind conditions – Part 1: Bubble distribution and development" by Helen Czerski et al., Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-103-CC1, 2021

I am delighted to see this research brought to publication. I hope this will be the first of several comments (limited largely by the time that I can find).

The authors note the importance of "flux", but I think they overemphasise this in lines 55 and following. It is certainly never ideal to know only that a bubble is present at a depth, but it is certainly useful in its own right especially with respect to bubble-mediated gas transfer. For bubble-mediated gas transfer, one key is to understand the role of the relationship between "lifetime" (i.e. how long a bubble is submerged between entraining and surfacing) and equilibriation time (the e-folding time for a specific gas to equilibriiate in a particular bubble by gas transfer). Where the e-folding time is the longer of the two, flux is dominant to the contribution to air-water gas transfer velocity and the contribution of all bubbles is limited to less or equal to "flushing rate/solubility" (see e.g. DK Woolf (1993) Atmosphere-Ocean 31 (4), 517-540). However, for a large bubble (typically short-lived and long equilibriation time) that limit is sometimes never approached even for fairly soluble gases such as CO_2. In that case, the more useful asymptote relates to "presence" or rather an additional surface between ocean and atmosphere. Also with respect to the asymmetry of gas transfer {e.g. Woolf and Thorpe (1991) Journal of Marine Research 49 (3), 435-466; Leighton et al. (2018) Scientific reports 8 (1), 1-9) it is the "presence at depth" that is crucial. [There is a crossover here with whether "aged" bubbles do actually dissolve, but I intend to address that in a separate comment].

I apologize if my comment is overly pedantic, but I'd like to avoid messaging that flux is all important. I think a balanced assessment is that we need to be able to confidently infer the history of bubbles from entrainment to either surfacing or senescence. The largely neglected topic of scavenging material from the upper ocean certainly depends on the full history. While primary generation of aerosol at the sea surface is a flux. it may be substantially altered by the history of the bubble. I am sure that your measurements and analysis will greatly enlighten that history.