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Interactive comment on "Measuring air–sea gas exchange velocities in a large scale annular wind-wave tank" *by* E. Mesarchaki et al.

Anonymous Referee #2

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General comments:

This paper is fairly well written and the approach is well explained. The results are interesting and should be published. There is obviously more to come from the experiments than is presented here. Whilst I am comfortable with the authors introducing this paper as the first of many, I do not see why they feel the need to discuss the other 12 chemical species if only data from two are presented? The authors' subsequent papers that discuss these other 12 compounds will easily be able to reference the calculations and experimental methodology presented in this paper. I therefore recommend removal of a lot of the references made to the other 12 compounds.

Within the paper, my main concern is the presentation of the low surfactant data. It is very interesting that the surfactant effect can be observed in the water-side controlled

gas measurements and cannot be seen in the air-side controlled gas data. However, without direct u* measurements, the inferences that might be made from Fig 9 are driven by an (assumed) interpolation between clean and high surfactant u* data. This suggests a trend that was not in fact measured. I recommend that these data are either removed or presented in a way that does not rely upon the u* data (and thus an interpolation).

Further, the manuscript needs some discussion of breaking waves and bubble formation in the Aeolotron tank. At what wind speed or u* value does/did this occur? How well/poorly does it reflect the real world? This is highly relevant when the authors begin to compare their data with other gas exchange parameterizations that have been derived from field experiments.

Specific comments:

Introduction:

Page 1644, Lines 14-15: Change 'In contrast, the surfactant affected CH3OH, the high solubility tracer only weakly.' to 'In contrast, the surfactant only weakly affected the high solubility tracer (CH3OH).'

Page 1644, Line 14: Suggest adding 'the relatively insoluble' before N2O.

Page 1645, Lines 4-8: This description is fine, but I think an equation showing the relationship between the different terms would be useful here.

Page 1646, Line 4: I would like to see some discussion of the eddy covariance technique here. The discussion of the measurement frequency limitations of the dual tracer approach is useful, but eddy covariance is also capable of resolving gas transfer estimates on short timescales. For example, the recent work by Yang et al (referenced later in the text) has provided novel estimates of soluble gas (methanol) transfer velocities. Other recent work by Bell et al., (ACP, 2013) suggests a possible role for wind-wave interactions in determining gas exchange. Further, the utility of using multi-

ple gases to understand physiochemical controls on gas exchange is not restricted just to wind-wave tanks. Eddy covariance offers this opportunity too (e.g. Miller et al., GRL, 2009).

Page 1646, Line 17: Change 'show clearly different' to 'clearly show different'

Methods:

Page 1647, Lines 12-18: Please define the various terms within the text immediately proceeding eqns 1-4. Having them in the legend of Figure 1 is useful but I would prefer that the information also be repeated here.

Page 1648, Lines 2 and 3: Replace 'soluble' with 'solubility' (x2)

Page 1648, Lines 5-7: Remove these sentences. They are repetitive as they are used in the figure legend as well as the proceeding section.

Page 1649, Line 10: Replace 'soluble' with 'solubility'. This appears to happen throughout the text – please check that all usages are correct.

Experiments:

Page 1652, Lines 5-6: Change 'the facility which leads off waves being reflected to the walls, results to a different wave field than on the open ocean' to 'the facility, which leads to waves reflecting off the walls and results in a different wave field to that found in the open ocean'

Page 1652, Line 16-21: Most of this information is repeated in the subsequent air and water phase sections. To reduce duplication of information, please remove this para.

Page 1653, Line 4: No need to discuss the measurement approach for halocarbons. Please remove.

Page 1652, Line 27: Insert 'air and water' between 'both' and 'phases'.

Page 1653, Line 13-16: This sentence is too long, confusing and poorly worded. Sug-

gest you divide into two sentences and rephrase.

Page 1654, Line 2: Replace 'avoiding' with 'to avoid'

Page 1654, Line 17: Replace 'to a field' with 'in a field'

Page 1655, Line 24: Again, remove the reference to halocarbons.

Page 1660, Lines 22-24: The sentence beginning 'For the last condition..' would be more appropriate in the Table legend. It is also unclear and needs to be reworded. I suggest 'For the highest wind speed condition of the clean case, only three repetitions were performed.'

Page 1660, Lines 24-25: This sentence is not very clear and initially seems to be a poor justification for subjectively removing data. The subsequent sentence attempts to justify removal by suggesting that the driver is a insufficiently skimmed water surface. If so, this would appear to be a source of potential error in the measurements. It suggests that the authors should exclude all of the data from repetition 2 rather than just the mean square slope.

Page 1660, Line 29 – Page 1661, Line1: See my general comment about interpolating u* between the high surfactant and clean cases.

Results:

Page 1661, Lines 5-15: See earlier comments about 14 tracers. This paragraph seems unnecessary.

Page 1661, Lines 18-22: The sentences beginning 'In both figures. . .' and 'Vertical light bars. . .' should be in the figure legend, not the main text.

Page 1662, Lines 5-6: This sentence beginning 'Small variations. . .' does not make sense.

Page 1662, Lines 8-9: Given that repetition 2 gave lower mean square slope values, I

think the data should be plotted against more than one physical parameter. Further, as the authors themselves note, 'one physical parameter [may not be] enough' to describe the processes controlling gas transfer. For these reasons, the gas transfer data should be plotted against Uref as well as against u*. In many ways this would be more useful information than the inset log-log plots in Figs 7 and 8.

Page 1663, Line 4: change 'decrease' to 'supressed'

Page 1663, Lines 6-8: The sentence beginning 'The clean water surface. . .' belongs in the legend of Fig. 9

Page 1663, Line 11: I disagree with the word 'ineffective'. Suggest you replace with 'less effective'.

Page 1664, Line 17: Replace 'weakly soluble, high soluble' with 'weakly soluble gases, high solubility'

Page 1664, Line 27: Remove comma

Page 1665, Line 2: Replace 'deriving' with 'derived'

Page 1665, Line 3: Please rephrase this sentence to make clear which studied 'these studies' refers to.

Conclusions:

Page 1665, Line 13: Remove comma.

Figures and Tables:

Table 1: See my general comment. I cannot see why a study that only presents data from two gases should include any information about the other 12 gases. Please remove this table.

Table 2: This table requires some further explanation as it confused me initially. Please rename the 'conditions' with something more meaningful. I suggest using either the

relevant Uref or U*w. In the legend, insert the word 'Case' before '1', '2' and '3' to make it clear that the cases are the clean vs Triton experiments. Also, you need to state somewhere that the multiples in brackets refer to the number of replicates performed for each Case.

Figure 2: Configuration makes it difficult to understand. Suggest configuration is changed so that it is a 3x2 set of panels. The panel a (wind speed) can be repeated in the top left and top right panels. Then the left hand column would be air and water concentrations for waterside experiments and the right-hand column would be the same for air-side controlled experiments.

Figures 9-11: These data need to be plotted with the transfer velocities not log-transformed if we are to really see how well the data compare with previous results and the magnitude of the surfactant effects on waterside controlled gas transfer.

Interactive comment on Ocean Sci. Discuss., 11, 1643, 2014.