Ocean Science Discussions

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Reply on RC2

Daniel Lee et al.

Author comment on "Drifting dynamics of the bluebottle (*Physalia physalis*)" by Daniel Lee et al., Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-39-AC2, 2021

We thank the reviewer for providing an interesting and engaging discussion. We have enjoyed reading their comments and watching the video, and will include some of these points in our manuscript. We are looking forward to seeing the results of the asymmetric drifter experiments, and agree that this is the way forward to validate Lagrangian particle tracking models, provided that the buoys behave similarly to Physalia.

The reviewer starts by discussing the effectiveness of modelling drift on the ocean surface using wind only. One argument for this strategy is that surface currents in the top few centimeters are mostly winds-driven, and not accurate in ocean models. While this is a good point, we note that the scientific community is increasingly interested in understanding the surface current shear (e.g. Haza., 2019), and the drifter experiments mentioned above go in the same direction. In our discussion we note that "the current relevant for this study is the surface ocean current which would be felt by the Bluebottle. Relatively good results from modelling studies which did not take into account the ocean current can be explained by the great impact the wind has on the top few centimeters of the ocean." (lines 332-334). We acknowledge that a model based only on wind can be an effective simplified solution to estimate drift. However, as mentioned by the reviewer, ocean currents will be critical during low winds or in situations where the current and wind have a similar effect on the Bluebottle. In addition, pre-existing ocean circulation was shown to be significant (although not dominant) for the drift of surface drifters in the top 5cm of the ocean during strong wind events (Lodise et al., 2019). The purpose of our manuscript is to present a theoretical model, based on the aerodynamic and hydrodynamic forces acting on the Bluebottle, as a foundation for improved modelling and future research. This is explicitly written lines 57-58 and 10-11: "Here we expand that model by adding the effect of the ocean current and simplifying the model down to an intuitive generalised vector form which could be implemented in Lagrangian models". "Adding assumptions to this generalised model allows us to retrieve models used in previous literature". The existence of wind based modelling methods does not diminish our interest in a theoretical modelling method.

Another point of discussion refers to some of the assumptions used in our study. At the beginning of section 3 (page 5), we discuss the aerodynamic and hydrodynamics centres of effort used by Iosilevskii and Weihs (2009) and the reasons we exclude these from our model. Currently, we do not have the specific measurements or controlled experiments required to analyse the centre of effort, nor to analyse the way Physalia moves as the wind and current conditions change, while considering its asymmetry. We state (lines 98-99) "similarly to the leeway methodology (discussed further in Sect. 6), the orientation behaviour of the Bluebottle (mainly represented by the angle of attack) can instead be determined by observations made in physical experiments". Once this information is available, it will be easily integrated in our model. Regarding the tentacles, the Bluebottles found on the east coast of Australia (which are the focus of this study) only have one main tentacle that is far shorter than that of the Portuguese Man-of-War found in the Atlantic, thus making the tentacles far less significant. The Bluebottle we photographed on Coogee beach, Sydney had a tentacle with a diameter of 1mm and length of less than 40cm when extended, and the area if more important than the weight to determine the physical forces horizontally. In our discussion (lines 356-358) we state that "The drag force from the Bluebottle's single tentacle (calculated using equations from Iosilevskii and Weihs 2009) is $O(10^{-2})$, which is insignificant compared to the overall hydrodynamic force acting on the Bluebottle of O(1)." Also, our photographs of the Bluebottle in water show the submerged body is a clump underneath the float with a similar width at many different angles, so the shape can be reasonably estimated as a symmetric cylinder under the water. Finally, the mathematical results in Section 5 provide case studies with simplified hypothesis in order to illustrate the results of the rather complicated model, by demonstrating its use and relating the results to previous modelling studies. As explained in the discussion (page 20), future research focusing on physical experiments are required to determine key parameter values and a detailed understanding of the specific habitat and life cycle of the Bluebottle.

Regarding the reviewer's comments on Figure 7 from Section 4.4, the purpose of this section is to analyse how adjusting the values of angle of attack and camber influence the Bluebottle's course. Since there are previous studies that model Physalia's drift as straight downwind, we include Figures 6 and 7 to show which model inputs result in a course straight downwind, and to demonstrate the capacity of the model to represent dynamics previously observed. Figures 6 and 7 are showing a Bluebottle with an angle of attack that is assumed to be a constant value of 0 and 90° respectively, which are the two ways to achieve this downwind course. However, this does not mean we believe both orientations would occur in the real world. We agree that in the situation shown in Figure 7, the Bluebottle would rotate to achieve a balanced position, thus changing its orientation. As we mention, a constant angle of attack of 90° has not been observed. We will remove this figure as it can be misleading and will rewrite the section to clarify this.

Finally, the reviewer questions Figures 10 and 11 and the orientation assumptions. As stated above, the purpose of the cases (which use a constant value for angle of attack) is to demonstrate the use of the model in a simplified case of a constant angle of attack, which is the main parameter controlling the orientation of the Bluebottle. We choose to use the most reasonable constant values of angle of attack (40° as observed by Totton and Mackie, 1960) for our examples, rather than defining an arbitrary function for angle of attack. Again, we agree with reviewer, controlled experiments in a tank or in-situ surveys will be the best way to determine how the angle of attack changes with conditions. Once this is achieved, the parameter of our model will easily be implemented, as a constant value or as a function of wind speed for example.

We thank the reviewer's for the comment on the size of the Portuguese Man of War, and have amended the text to "up to 15 cm". While we agree that that tentacles most likely don't exceed 3 metres when not fully extended, Munro et al. (2019) mention that they can reach up to 30 m in mature colonies. We will amend this as well.

References:

Haza, A. C., Paldor, N., Ozgokmen, T. M. M., Curcic, M., Chen, S. S., & Jacobs, G. A.: Wind-based estimations of ocean surface currents from massive clusters of drifters in the Gulf of Mexico. Journal of Geophysical Research: Oceans, 124, 5844– 5869.

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