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Interactive comment on "OUTPACE long duration stations: physical variability, context of biogeochemical sampling, and evaluation of sampling strategy" *by* Alain de Verneil et al.

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This manuscript is concerned with the evaluation of the Lagrangian nature of series of measurements made using a drifting mooring as a reference center. Specifically, the main goal of the study is to define an objective measure to quantify the degree to which sampling along the trajectory of a drifting mooring can be considered Lagrangian (with the ability to choose a threshold value for that measure beyond which the observations will not be considered Lagrangian). This is a methodological topic, yet it should be of interest to a relatively broad audience concerned with physical and biogeochemical ocean observations. The text, figures and captions are clear and informative (except

in very few places, see below). On the other hand, the scientific context and working hypotheses underlying the study are not adequately posed in my opinion. Suggestions are provided below on how to improve this, which may simply involve modifications of the text. Alternatively, a more in-depth revision could make use of numerical simulations to carefully evaluate the proposed Lagrangian evaluation method.

Main comment: the scientific context and working hypotheses underlying the study are not adequately posed.

This is perhaps due to the fact that the authors are venturing into "new territory". There have been past studies attempting to quantify departures from pure Lagrangian motion associated with drifter trajectories (D'Asaro 2003) but the context of the present study differs. Indeed, the drifting moorings deployed during OUTPACE are not expected to precisely follow a water parcel of infinitesimal size but rather to remain in a given environment having a finite vertical heigth (defined in terms of density range in that study). The reader attention should be clearly drawn to this specificity at the beginning of the paper. An important consequence noticed by the authors (but in their final sections) is that, except in a perfectly barotropic flow, the mooring trajectory will not be truly Lagrangian at any vertical level. In this context, and ignoring vertical motion, the three key elements of the problem are 1) the vertical shear of the flow 2) the structure of the mooring and the vertical distribution of the drag force 3) the horizontal scales over which the environment can be considered homogeneous (the scale may vary as a function of depth, e.g., scales may be shorter near the surface where submesoscale turbulence tends to be intensified).

Several remarks are in order. With respect to 3) it seems difficult, except in rare cases, to define an average scale as done in the present study. Indeed the Rz defined by the authors ignores the Lagrangian aspect of the circulation. A fast moving environment eg in the vicinity of a hyperbolic point, will be systematically poorly evaluated from the perspective of the ability of OUTPACE moorings to remain Lagrangian, but for erroneous reasons because only the intensity of the shear (which may or may not be stronger in such regions) matters. Likewise, a mooring embedded into a mesoscale structure may lead to a near-perfect “Lagrangian trajectory” (in the sense that the mooring perfectly tracks at all depths the coherent water masses trapped into the eddy) while travelling distances greater than Rd (eg, on time scales of weeks to months). I understand that the OUTPACE setting is one in which mesoscale are weak and this is explicitly stated by the authors. But then, could the authors strive to precisely describe the kind of dynamical regime they are in, and how it affects the general problem that is the motivation of the study ? If mesoscale turbulence is irrelevant then waves with different scales should dominate, typically Rossby waves, inertial waves, and tides. And only the motions with time scales longer than the station duration impact the “quasi-Lagrangian strategy” through their vertical shear. This is explicitly mentioned by the authors (p15 lines 23-25) but again, these concluding remarks come way too late and should have guided the whole validation design.

In any event, whether or not the presented work is only valid in one regime or not, it is unlikely that a proper metrics for how Lagrangian the observations are can exclude the measured vertical shear in the area. As for the rule of thumb that displacements longer than Rd should raise suspicion, I would certainly argue that this is too general a statement to be supported by the present work. Likewise the suggestion that there might be inappropriate flow regimes (p17 line 15) is not well supported and may have to be reconsidered.

Overall, it seems to me that the introduction should i) present the processes that can break the Lagrangian nature of the sampling approach implemented by the authors ii) briefly review how different dynamical regimes may be differently affected 3) present the OUTPACE regime of interest in which they will develop their methodological approach. This would allow the authors to put their work on much firmer ground and help them write a more robust discussion section.

If the authors intend to keep using this type of observational approach, I would additionally suggest a numerical investigation in which drifter trajectories advected with

velocities computed by several weighted vertical averages are compared with trajectories for drifters that are localised at particular depths and thus Lagrangian (if w can be ignored). Such a study might well reveal the broad range of Rz spatial scales coexisting in a given location even with limited mesoscale activity. A numerical investigation with biogeochemistry would even allow the authors to explore the limitations raised by reviewer 1.

Minor comments: abstract: "homogeneous" may be better suited than "self-similar". p4 line 10: "Square regions ...". I find this sentence unclear. p9 line 22: Not clear. Rephrase perhaps as: "The increase in salinity maximum from LDA to LDC reflects ..." p15 line 33: " Rather than an elevated shearing apart ...". Awkward sentence

Reference: D’Asaro, E. A. (2003). Performance of autonomous Lagrangian floats. Journal of Atmospheric and Oceanic Technology, 20(6), 896-911.

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