We thank Dr. Xavier Capet for his time and effort in both reading the submitted manuscript and providing his thoughts and comments. Below is his original post (in italics), with our own responses interspersed within. Manuscript additions are written in blue, with deletions in red strikethrough.

Reviewer:

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 mooring 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 height (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 traveling 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 metric 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.

Response: We agree that the concerns brought up in these comments should be addressed early in the manuscript, particularly in the introduction. The difference between neutrally buoyant drifters such as in D'Asaro (2003) and quasi-Lagrangian platforms, and the expectation that the latter will not be particularly Lagrangian for an extended period, needs to be highlighted. Also, the flow regimes that complicate these drifter deployments (and not treated by this method) will be specified. Finally, a characterization of the regime we are targeting is included:

> Sect. 1, Pg. 2, Line 16: Naturally, the question arises whether the trajectory undertaken by the drifting mooring in the quasi-Lagrangian approach accurately represents the water movements at each of the sampling sites. If the drifter is successful in following the water, then indeed a single biogeochemical setting will have been sampled; if not successful, then the risk grows that a different environment has been brought in via advection. Previous efforts by physicists to make floats Lagrangian show the effort needed to make an instrument neutrally buoyant, and they have been instrumental in demonstrating complicated flow regimes (D'Asaro et al., 2011). In contrast, the quasi-Lagrangian platform, with a variable distribution of incubation bottles, will necessarily fail to be Lagrangian in finite time outside of a barotropic flow where currents are the same throughout the water column. Ensuring the success of this strategy thus requires taking into account how different currents potentially shorten the timespan of validity. In fast-moving flows with strong vertical shear and possible vertical motions, such as zones of enhanced mesoscale turbulence near fronts and filaments, the drifter will not be Lagrangian long, perhaps not even a day. Alternatively, if a drifter is trapped inside a coherent eddy, it can follow a similar water mass for a long time (weeks to even months) over great distances. Periodic vertical shear can also arise due to waves and tides, so displacements due to them must also be considered. In deployments lasting several days but less than a week, these are longer than internal waves, inertial frequencies and tides which we will consider, but less than the

passage of Rossby waves which will be ignored. As a result of all these possible motions, it is therefore necessary to carefully consider site selection and dynamical regime before deployment. Unless the focus of study, fronts and filaments might be avoided because constant shearing will quickly separate water parcels at different depths in the direction of the structure's alignment. Fortunately, finding signs of their presence has become more feasible with satellites. An eddy can be targeted because of its coherence, and there are ways to confirm that sampling is indeed inside of it (Moutin and Prieur, 2012). In other words, if a physical structure is targeted or identified, its particular nature supercedes other considerations. These structures are not necessarily representative of the world Ocean, and so for biogeochemical measurements to reflect predominant conditions it is necessary to sample elsewhere. For the campaigns where sites are far (possibly by design) from obvious, organized mesoscale structure and lasting around several days to a week, there is still a need to conduct an independent, post-cruise validation of the drifter's success, ~~In practical terms, ensuring the success of the quasi-Lagrangian strategy leads to a two-step process. First, the selection of sampling sites needs to be carefully considered. Sites should be relatively uniform to provide room for error should the drifting mooring wander too far from the true water displacement. Prior to the advent of satellite oceanography, structures harboring enhanced gradients such as eddies and fronts were difficult to detect before sampling. As a result, the risk always existed that sites could be chosen close to these structures, putting the drifter's mission into jeopardy. In recent years, the incorporation of near-real-time satellite data having become routine minimizes this (in the list above, since the BOUM 2008 campaign; Moutin et al., 2012). The second step, after deployment of the drifting mooring, consists of an independent, post-cruise validation of the data~~, which is the focus of the present study.

Reviewer:
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 localized 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.

Response: Conducting a numerical study, possibly with a biogeochemical component, would indeed be a necessary step to refine this methodology for the various flow regime scenarios brought up in these remarks. We feel, however, it is beyond the scope of this paper. As part of the OUTPACE special issue, this paper's aims are to provide context for these specific deployed drifter samples and evaluate their validity in representing individual environments, albeit embedded within flow regimes that we feel are appropriate for our chosen methodology. Seeing as how the quasi-Lagrangian platform is a popular one, and will continue to be used by numerous research groups, we welcome the suggestion and invite a potential future collaboration to expressly explore its limitations.

Reviewer:
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.

Reponse: The following changes will be made to the manuscript:

Sec. Abstract, Pg. 1, Line 10:
…their own sufficiently homogeneous ~~self-similar~~ physical environment …

Sec. 2.2, Pg. 4, Line 10:
~~Square regions of sides 120 km long, centered at each LD station, were chosen as the boundaries.~~ The spatial range consisted of a 120 x 120 km box centered at each LD station.

Sec. 3.2, Pg. 9, Line 22:
The increase in salinity maximum from LDA to LDC ~~The salinity maximum~~ reflects ~~sampling along the latitudinal gradient of~~ the high salinity tongue of the South Pacific…

Sec. 4.2, Pg. 15, Line 33:
~~Rather than an elevated shearing apart, h~~However, the ~~rate of~~ exponential growth rate was so low that it took over a week for the relative …