Response to Review # 1 for OUTPACE LD Station Paper:

We thank Reviewer #1 for taking the time to read the submitted manuscript and providing their thoughts and comments. Below is the original response from Reviewer 1 (in Italics), with our own responses interspersed within. Manuscript changes are shown with additions in blue, deletions in red strikethrough.

Reviewer:
General comments: This is a quality paper, suitable for publication, sharply focused on the specific issue of whether a "Lagrangian" biogeochemical drift station lasting a few days is truly following the same piece of water. The methodology is sound, but focused only on the tools and environment associated with the OUTPACE program. Other environments, such as the subpolar North Atlantic during the Spring Bloom would have very much smaller scales.

The major assumption of the analysis is that the temperature and salinity variability can be used as a proxy for biogeochemical variability. Clearly if there is a strong physical change, then it is more likely that they will also be different biogeochemical regimes.

However, there can also be biogeochemical variability that is unrelated to physical variability, even variability in biogeochemical variables purely due to physical affection that is not apparent in the temperature and salinity fields. Thus the analysis presented here is closer to a necessary condition for a good Lagrangian trajectory, but is not necessarily a sufficient one.

The only true measure of biogeochemical variability around a quasi-Lagrangian trajectory is the actual variability. This will be different depending on the variable measured and the depth at which it is measured. Given the ability to make simultaneous measurements of many biogeochemical quantities from multiple drifting platforms, and the ability to autonomously survey around a platform, measuring in many places around a Lagrangian platform is becoming increasingly possible.

Response:
The reviewer's main points are important and well-founded. Yes, the paper is focused on the data and context of OUTPACE, and other environments such as the North Atlantic Spring Bloom would have variability (perhaps both biogeochemical and physical) on much smaller scales. The hope in this manuscript is to generate a conversation regarding the best approach to ensure that biogeochemical measurements from drifting platforms are indeed reflective of a single biogeochemical environment's evolution, even when gradients exist at smaller scales.

As the reviewer points out, we use physical variability as a proxy for biogeochemical variability. The reviewer further adds that while a physical regime change can be indicative of a biogeochemical regime change, an absence of physical change does not necessarily preclude the existence of biogeochemical gradients. This is a critical point, and it represents a weakness in our approach. Indeed, as the reviewer suggests, our methodology may represent a necessary, but not sufficient, criteria to answer our question: Did the drifter and related station sampling stay in one biogeochemical context?

While we did include satellite data showing little detected surface gradients in SST and chl-a to support application of our method, this does not refute the Reviewer's point. To clarify this caveat and bring it to the reader's attention, we will add the following changes to the manuscript:

Introduction, Pg. 2, Line 26:
… which is the focus of the present study.

Before proceeding into this study's description of our methodology, a few remarks are needed regarding its applicability. We already mentioned that we will consider regions away from strong, organized mesoscale structure. Additionally, the method relies upon independent physical, not biogeochemical, measurements to indicate a change of water mass due to the drifter not being Lagrangian. This approach does not detect the existence of biogeochemical gradients in water that might exist on smaller scales, so future application of our method requires the user to apply contextual knowledge of their sampling region and keep this possibility in mind. For this study, a regional biogeochemical gradient was expected (Moutin et al., 2017) and rationales for this method's application will be provided.

The Oligotrophy to UlTra-oligotrophy …

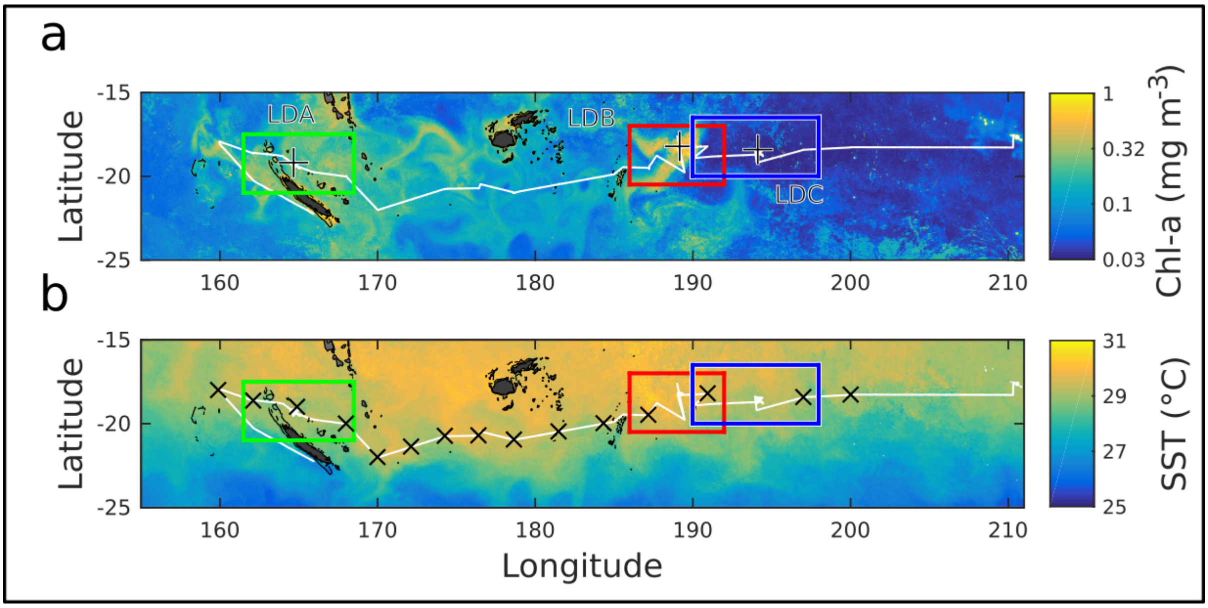
Reviewer:
Specific comments Section 2.1 – How many drifters were deployed that were different from the drifting moorings? Where were they deployed relative to the moorings?

Response: The SVP drifters were the only different drifters that were deployed, with their numbers provided in Table 1. The mean distance between their deployment position and the first SedTrap position will be added to the methods section:

Sec. 2.1, Pg. 3, Line 14:
Before starting each LD station, surface velocity program (SVP; Lumpkin and Pazos, 2007) drifters were deployed adjacent to the site. The numbers of drifters deployed are summarized in Table 1, and their grouped mean initial positions were 1.1, 1.6, and 0.9 km away from the start of station LDA, LDB, and LDC, respectively. At the start of each station, t~~T~~wo quasi-Lagrangian drifting moorings were deployed….

Reviewer:
How were the SD stations placed relative to the LD stations? Was there any attempt to do a survey around the LD stations?

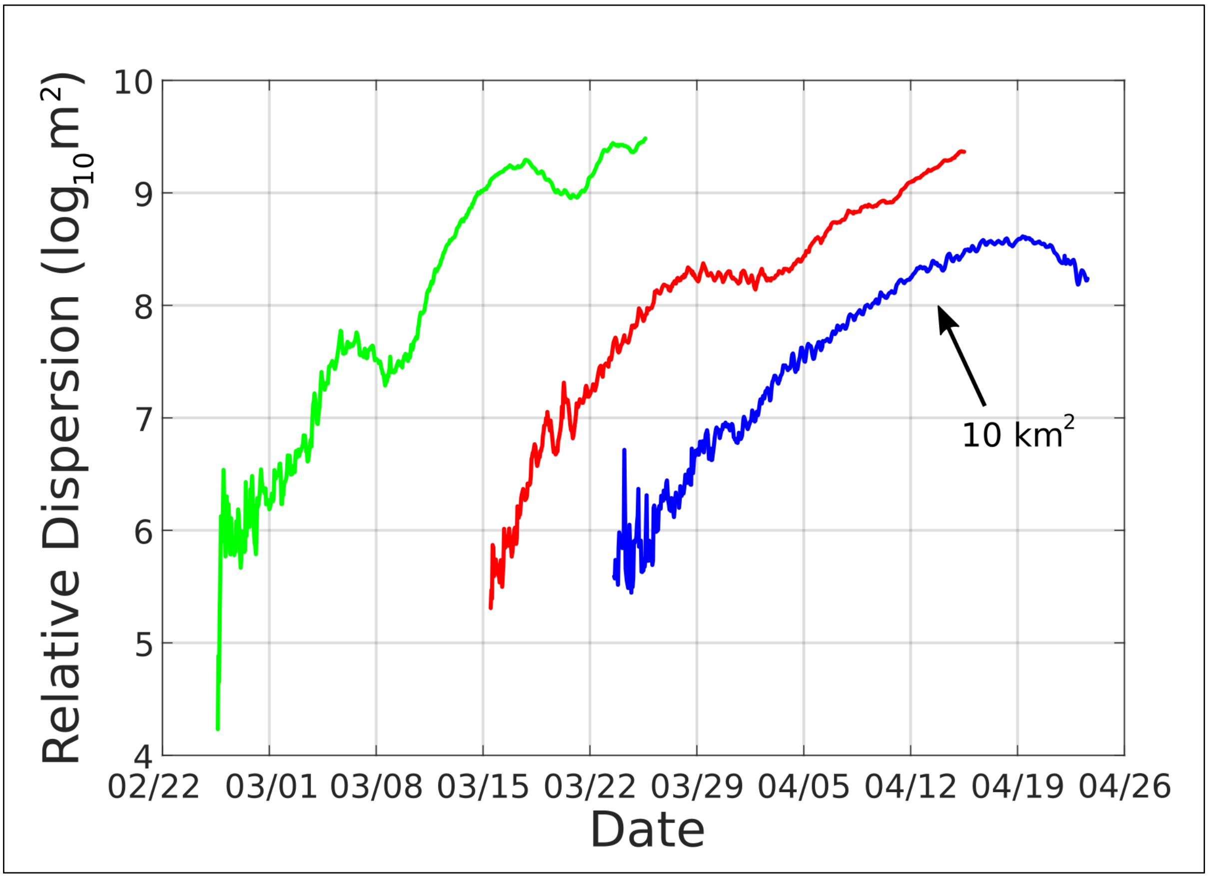
Response: Since the LD stations were the focus of the manuscript, Fig. 1 did not include the SD station positions. They will be added to Fig. 1b in lieu of repeating the LD stations (see below). The SD stations were positioned to be roughly equidistant from each other, and site selection is further detailed in the preface of the special issue (Moutin et al., 2017).



Regarding attempts to survey around the LD stations, indeed there were surveys using a Moving Vessel Profiler (MVP), which produces high-resolution profiles. These data were used in another publication in this special issue focusing on LDB (de Verneil et al., 2017). However, as detailed in the supplementary information from that text, technical difficulties led to salinity variability that, while sufficiently accurate to recover profiles of the density stratification, were deemed to be too variable for direct use in calculating Spice and Z-score values. Generally speaking, having exploitable depth-resolved data at these intermediary scales of 10-100 km would indeed be very useful, and the collection of these data was included in our list of recommendations.

Reviewer:
Figure S3 – Would be nice to additionally label the dispersion plot with units of meters and kilometers to guide the reader, i.e. 10^8 m^2 is (10 km)^2

Response: A unit guide will be added to Fig. S3 (see below).



Reviewer:
Recommendations – Although the first Rossby radius appears to be a good scale here, it is certainly much too large in other, more patchy environments.

Response: We agree that in other environments that the Rossby radius may be too large a scale, and update the manuscript's recommendations as follows:

> Sec. 5, Pg. 17, Line 19:
> Upon arrival at the selected site, a deep CTD cast below the thermocline can be used to quickly calculate the local RD Rossby radius in real time and produce a rough estimate for maximum spatial scale. In patchier environments, this scale might be too large, and must be reduced.