The detailed reply to the referees' comments was already submitted in the interactive discussion. We made a couple of changes relative to our previous reply in this submitted version of the manuscript:

- We eventually reverted from the term 'Lagrangian decorrelation' to 'apparent decorrelation' to refer to the drift-induced decorrelation. We find 'Lagrangian decorrelation' to be better suited to describe the total decorrelation one can observe in the Lagrangian data (i.e., the sum of the drift-induced or 'apparent' decorrelation and the decorrelation of the IT).

- Concerning the uncertainty of the complex demodulates: we did not use the Monte Carlo method we referred to in our previous reply. Instead, we argue that the uncertainty of a sample autocovariance is a reasonable estimate of the uncertainty of the envelope (i.e., the demodulate) of that sample autocovariance (as an estimate of the true autocovariance). If this uncertainty range is larger than the envelope of the sample autocovariance, the conclusion is not that the envelope of the true autocovariance can be negative, but that it is not significantly different from zero (see paragraph lines 170-179).

One reason for not directly estimating the uncertainty of the demodulates is that the demodulate of a sample autocovariance can be shown to be biased high (relative to the demodulate of the true autocovariance). This is easily seen in the behavior at long time lags of the demodulates of the example Argo sample mean autocovariance plotted in Fig. 2b. The expected behavior of the demodulates of the underlying true autocovariance is to converge to 0 (as can be seen from the Argo global mean series in Fig. 12). In two distinct occasions we can safely consider this bias to be small: (i) At short time lags, all the sample autocovariances used to compute a local mean autocovariance can be considered to be correlated (i.e., in phase with each other). (ii) For a large sample size, the error of the mean autocovariance (proportional to 1/sqrt(N), where N is the number of samples) becomes very small. Therefore the sample mean autocovariance is very close to the underlying true autocovariance function.

This new definition of the uncertainty, and the updated Argo dataset account for slightly different quantitative results compared with the previous version of the manuscript.