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Interactive comment on "Phosphate supply explains variation in nucleic acid allocation but not C : P stoichiometry in the Western North Atlantic" *by* A. E. Zimmerman et al.

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We would like to thank the reviewer for their thoughtful comments on our manuscript. We have taken the reviewer's concerns into consideration and revised the manuscript accordingly. Our responses to each point are detailed below.

Point 1: The authors estimate the flux of phosphate from assessing the phosphate gradient between 80 and 160m and multiply by Kz. The authors collected samples for particulate phosphorus, DNA and RNA from 0 to 5m (as far as I can tell). The authors then correlate fluxes from ∼100m to properties in the top 5m. In a severely phosphate depleted system, do the authors believe that phosphate that is supplied at ∼100m

will reach the phytoplankton community living in the top 5m? Even if we assume that phytoplankton are circulated in the mixed layer, in these stratified environments, the mixed layer is much shallower than the euphotic zone. The lack of correlation for most flux-property plots would suggest there is a mismatch in the sampling horizons perhaps? This needs to be addressed in the paper.

Response: The reviewer raises a valid point about the depth over which the phosphate flux calculations are done. The depth range 80-160m was used for the flux calculation because phosphate was drawn down to our method detection limit at shallower depths. As such there is no 'gradient' that can be calculated. If the entire depth range of 0-160m is used, the upper 80m has a disproportionate impact on the calculated gradient, so as to increase it, and thus leads to input fluxes that are too high and simply don't make a lot of sense (ie., if they really were that high, and assuming a fast growth rate, there would still be residual phosphate in the water column and there isn't). Therefore we can only practically calculate for the depth range where we have residual concentrations. We have added a statement to the Methods to clarify this.

The reviewer also asks if we believe that nutrients fluxing through the base of the euphotic zone make it into the mixed layer. We have observed this to be the case for nitrogen (Fawcett et al., 2011, 2014). These studies clearly show that some phytoplankton in the summer mixed layer are obtaining nitrate from depth based upon their isotopic signature. However, we don't know the mechanism, whether it be differences in mixing thresholds or vertical migration (see Fawcett et al., 2014). Furthermore, it has been shown in both the tropical North Pacific and subtropical North Atlantic that there is excess primary production in the euphotic zone that is devoid of nutrients (Johnson et al., 2010; Johnson unpubl. data). Again, the mechanisms are not known but clearly the flux of nutrients into the mixed layer and euphotic zone is more complicated than currently appreciated. The discussion has been revised to recognize the potential mismatch, but present the supporting evidence described here.

Fawcett, S.E., Lomas, M.W., Casey, J.R., Ward, B.B., Sigman, D.M. 2011. Eukaryotes

dominate new production in the Sargasso Sea. Nature Geosciences, 4: 717-722.

Fawcett, S.E., Lomas, M.W., Ward, B.B., Sigman, D.M. 2014. The effect of summer-to-winter mixed layer deepening on eukaryotic new production in the Sargasso Sea. Accepted, Global Biogeochemical Cycles.

Johnson, K., Riser, S., Karl, D., 2010. Nitrate supply from deep to near surface waters of the North Pacific subtropical gyre. Nature 465: 1062-1065.

Point 2: In Figures 5, 7 and A5, there is an obvious high data point that is perhaps controlling the strength of the correlation analysis. Is the correlation between properties or flux- properties still significant when this data point is removed?

Response: This is an excellent point, so we chose to analyze relationships with SRP flux by ranked correlations specifically due to the obvious high data point at 35.67°N (St16). As opposed to absolute values, using ranked data reduces sensitivity to omission of any one data point. We have added a statement of this rationale to the Methods. Regardless, we also evaluated all correlations with and without St16. Results for all analyses were qualitatively similar (i.e., statistically significant relationships were still significant and vice versa), except for particulate organic carbon and SRP flux (Fig. A5), where the P value is 0.022 including St16 and 0.072 excluding St16.

Point 3: The assumption is that the supply of phosphate will have an impact on cellular P content and allocation. But a supply of phosphate will also supply nitrate, silicate, iron etc. So how will this affect the carbon (e.g. if there is a stimulation in carbon fixation and cell growth) and therefore the C:P ratio. The current version of the manuscript reads as though the only property to change if phosphate is supplied is particulate phosphorus.

Response: Certainly the factors influencing cellular carbon and phosphorus content, and consequently C:P ratios, are complex. Supply of phosphate from depth will likely supply other nutrients simultaneously, though high N:P (see response to Reviewer 2, Point 4) suggests P may be limiting, relative to N. Additionally, inputs of silicate should

not have had a significant impact since diatoms were not a large component of the community at our sampling stations. Most of the iron in surface waters is derived from atmospheric deposition, especially in the North Atlantic, which receives inputs of iron-rich Saharan dust (Duce and Tindale, 1991; Wu et al., 2000). Together with our measurements of high C:P ratios, these points indicate that this region is likely P-stressed, so it is probable that P is regulating growth and biomass accumulation. We have revised the discussion to highlight previous evidence of P-stress in this region (Ammerman et al., 2003; Cavender-Bares et al., 2001; Cotner et al., 1997; Mather et al., 2008; Wu et al., 2000), but also recognize the potential influence of other factors and the limitation of our methods in teasing apart the individual effects of multiple nutrients.

Ammerman, J.W., Hood, R.R., Case, D.A., Cotner, J.B. 2003. Phosphorus deficiency in the Atlantic: An emerging paradigm in oceanography. Eos 84(18):165-170.

Cavender-Bares, K.K., Karl, D.M., Chisholm, S.W. 2001. Nutrient gradients in the western North Atlantic Ocean: Relationship to microbial community structure and comparison to patterns in the Pacific Ocean. Deep Sea Research Part I 48(11): 2373-2395.

Cotner, J.B., Ammerman, J.W., Peele, E.R., Bentzen, E. 1997. Phosphorus-limited bacterioplankton growth in the Sargasso Sea. Aquatic Microbial Ecology 13:141-149.

Duce, R.A., Tindale, N.W. 1991. Atmospheric transport of iron and its deposition in the oceans. Limnology and Oceanography 36:1715-1726.

Mather, R.L., Reynolds, S.E., Wolff, G.A., Williams, R.G., Torres-Valdes, S., Woodward, E.M.S., Landolfi, A., Pan, X., Sanders, R., Achterberg, E.P. 2008. Phosphorus cycling in the North and South Atlantic Ocean subtropical gyres. Nature Geoscience 1, 439-443.

Wu, J., Sunda, W., Boyle, E.A., Karl, D.M. 2000. Phosphate depletion in the Western North Atlantic Ocean. Science 289:759-762.

Interactive comment on Biogeosciences Discuss., 10, 16295, 2013.