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Interactive comment on "Understanding predicted shifts in diazotroph biogeography using resource competition theory" *by* S. Dutkiewicz et al.

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General Comments:

The authors use nutrient supply ratios to explain the shift of the modeled nitrogen fixation biogeography. This is an interesting work for improving our understandings of model performance under changing climate. The manuscript is generally concise, well written, and the results are well presented.

Although I agree to use the nutrient supply ratios to interpret the results of this SPECIFIC model, I doubt if they can be extended to predict shifts of the diazotroph biogeography. It depends on how the model is constructed. As in the model of this study the diazotroph growth is determined largely by nutrients, the nutrient supply ratios are

certainly important in the model results. However, my and colleagues' recent studies (Luo et al. Earth System Science Data 2012; Luo et al. Biogeosciences 2014) based on field measurements do not support that nutrients are the most important factors controlling N2 fixation.

As shown in Fig. 1e of this manuscript, measurements show that diazotrophs are most abundant in tropical Atlantic, while very low in subtropical Atlantic. In our papers we also show that N2 fixation rates have same pattern. In addition, we found N2 fixation rates are always high in the Pacific. Even in the South Pacific where the diazotroph abundance seems low, the N2 fixation rates are still high. We believe the N2 fixation activity in tropical Atlantic > Pacific > subtropical Atlantic. With further assessment of environmental parameters including physical conditions and nutrient concentrations, we found:

(1) Solar radiation and subsurface oxygen concentration are the best two predictors for the observed spatial distribution of N2 fixation rates. In the model of this manuscript, solar radiation (energy supply) may not be set up as important as nutrients in controlling diazotrophs, although both solar radiation and nutrients are both the fundamental resources for autotrophs. This could be one of the reasons that the model predicts the existence of diazotrophs in cold subarctic regions (Province III&IV in Fig. 3a).

(2) Iron is not a good predictor on global scale. Apparently dust deposition in Pacific is the lowest, but N2 fixation rates in Pacific are higher than the subtropical Atlantic where the dust deposition in higher. If we just pick out Atlantic, both dust deposition and subsurface oxygen concentration have equal predicting power for N2 fixation rates. As shown in Fig 1f of this manuscript, the model does not reproduce this pattern even in just Atlantic – why dust deposition is highest in the tropical Atlantic while its diazotroph abundance is low?

(3) We also checked P*, a representative of N:P nutrient supply ratio, it does not show strong correlation to N2 fixation rates.

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I generally support to publish this manuscript. But I'd like to see this inconsistency between the model and the observations to be discussed in this manuscript, to alert the readers that diazotroph biogeography cannot be simply predicted by nutrient supply ratio.

Specific Comments:

P7115, ln 11, Luo et al. 2012

P7116, ln 15-end, as discussed above, the model does not reproduce the real pattern of diazotrophs and N2 fixation activity.

P7118, ln 13, Eqs. 3-5

Table 3 RNij, please give out parameter values used in this study as they are important in evaluating the model results.

Section 3.1 & Table 5: It seems to me that from Province I to VI, iron is increasing and phosphorus is decreasing. Clarifying this may help readers understand the biogeography.

P7119 ln 18-25 & Table 4 Equilibrium Solutions: I'd prefer to see the definitions of the symbols right under the table, instead of buried in the main texts.

P7120, ln 16, ln 23-25: It is not precise to use "slightly above one". What is amount of "slightly"? It also does not have a clear explanation why the threshold will not be exactly one.

P7120, ln 22: do not use subscripts for ">1"

P7124, ln 13, remove "an"

P7127, ln 13-14, (Luo et al., 2012)

Fig 1. Caption line 5, Luo et al. (2012)

Fig 2. Caption "Dashed blue line . . . Qpn=1 & Qfen=1". That does not make sense to

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me as Qpn and Qfen cannot be identical. Do you mean that one of them >1 and the other=1? Same for Fig 6.

Fig. 4&7: Put legend of the lines instead of explaining the color of the lines in text. Also please label the x-axis (I assume the numbers are in degree North).

Fig. 7: Mark the new province boundaries as you have done in Fig. 4.

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