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Interactive comment on "Contrasting juxtaposition of two paradigms for diazotrophy in an Earth System Model of intermediate complexity" *by* Ulrike Löptien and Heiner Dietze

Anonymous Referee #2

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General Comments

The paper looks at two different formulations of Nitrogen fixation, which are then fitted to the nitrogen fixation observations to obtain the best solution. They show both formulations can adequately represent observations today but deviate when using the RCP8.5 future scenario. I like the inverse approach to parameterising the two N2-fixation formulations using observations. Interestingly, both formulations can represent today's limited N2-fixation data. However, to make the study more complete and justify publication, it needs expanding to address the following issues.

1. It is not clear what observations are used to constrain N2-fixation formulations. It is

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stated that both models faithfully capture the other key BGC fields like NO3, PO4 and oxygen. However, you should show and quantify how well these fields are simulated by the best parameters of your two N2 fixation formulations. What are the differences? How about differences in DIC and air sea carbon fluxes, and volume of anoxic water? Do the differences provide any insight into the suitability of the 2 different formulations? No, can be the answer, but it would be helpful to show this more explicitly.

2. Typically in applying an inverse approach one considers other observations that were not used to constrain the model to assess the solutions. Here the future projected response is used, but you should consider other potential sources of information. A couple of ideas are: 1) does/would N15 differ between the two models?; 2) do any of the other BGC fields, like the ones listed in 1, differ significantly in the two formulations?; 3) does the ocean carbon uptake differ?; 4) does the response to ocean variability differ (e.g. ocean variability from atmospheric forcing of the last 5 decades)?; What I'm looking for is some guidance on whether other features of the two N2 simulations could provide useful insight to access their suitability and direct where to target future observations. Looking at natural variability in the ocean is one way to provide insight into how the two formulations respond in a way that could be assessed against our current understanding and observations. You should add this to the paper. I would also say that relying on more N2 fixation data would not enable one to choose the most suitable N2 formulation now since the simulated N2 fixation fields look similar. At what point in the future do the differences become significant? Is it the pattern or the total amount of N2 fixation that is most helpful in differentiating between the two formulations?

3. In the simulated future projection, the study only shows the global N2 fixation response of the two formulations, but do other BGC fields show significant differences too? How does the spatial distribution of N2 fixation change? Does an increase in N2 fixation significantly change ocean carbon uptake, equatorial net primary production, volume of anoxic water? Both the change in the amount and distribution of N2 fixa-

tion can impact the other BGC fields and fluxes in important ways - does this occur? I'm looking for reasons for why I should care about the future N2 fixation response? I assume the projected differences in the N2 fixation have impacts on the ocean BGC behaviour - it would be great if you showed it.

A few detail comments

line 15, nitrogen is also abundant in the ocean too line 19, not in the air but dissolved in the ocean line 22, what input? state it is the added Bio-available nitrogen line 31, not clear what is vicious cycles is - expand line 133 - only fit N2-fixation? how well do you simulated other BGC fields and fluxes?

line255 - observations show very low biomass of N2 fixers - is this believable? the two N2 formulations differ in the projected response of N2 fixation to global warming but could we use ocean variability over the past few decades to determine which one is more realistic?

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