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Interactive comment on "Modeling the impact of iron and phosphorus limitations on nitrogen fixation in the Atlantic Ocean" by V. J. Coles and R. R. Hood

Anonymous Referee #1

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Coles and Hood Review-

Coles and Hood use a coupled physical-biological model of the North Atlantic Ocean to simulate the subsurface N* values and estimate the rates of nitrogen fixation necessary to attain these values. The N* values are broadly simulated, but N2 fixation rates are relatively high in order to accomplish this. This high N2 fixation rate is achieved by altering the phosphorus to nitrogen remineralization rate approximately two times in favor of faster phosphorus mineralization. This works because phosphorus is the nutrient that limits N2 fixation in the model. The model also simulates the surface inorganic nutrient concentrations with varying degrees of success, but seems to do a

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better job with profiles as the authors indicate.

Overall, this is a novel approach to modeling the contribution of nitrogen fixation in the North Atlantic that provides insight into the importance of N2 fixation in the N. Atlantic. I have several questions and comments that are listed below.

1. The model is a coupled physical-biological model of the N. Atlantic yet there is very little information here on the physical model. The authors should address why this is or put some data in the paper that describes how well the physical model simulates the system (temperature profiles, mixed layer depths, etcĚ) This is already a very dense paper and perhaps this is why the data is left out, however this data may be helpful in assessing the validity of their approach considering some of the chemical profiles under- or overestimate field data.

2. Deposition of dust adds to the Fe detrital pool in the model; does N and P from dust go into the detrital pool as well? Wouldn't this alter N* in favor of higher values (as P in dust is relatively low- see Baker et al 2003 GRL) while at the same time decreasing the contribution of N2 fixation necessary to get the observed N*?

3. N* is dependent on both N2 fixation and denitrification, yet there is little mention of denitrification in the paper. Can the authors add to the paper the importance of denitrification in setting the N:P of the source waters in to the N. Atlantic basin and how sensitive the model is to this denitrification?

4. The growth equations do not seem to have temperature dependence? Is this so, or am I missing this? Can the authors explain why?

5. The Ks for the phytoplankton seems quite high especially for a picoplankton-dominated system. Likewise, the Trichodesmium cannot be limited by N in this model, however they have a Ks- actually quite high. In the oigotrophic N. Atlantic DIN concentrations rarely get this high in the surface waters, but I am not sure in the model as there is no N data presented (can the authors provide N data?) However, Fig 7 shows that N

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limits phytoplankton growth which may be the case throughout the N. Atlantic. Can the authors provide justification, or a reference, for the high Ks for nitrogen? Likewise, does lowering the KsN result in a more NP co-limited system with respect to phytoplankton growth?

5. I am a little confused why PO4 is the dominant limiting nutrient for N2 fixation when figure 8 shows the P and Fe co-limit diazotrophy. Does Fe constrain N2 fixation to a lesser extent? Does N2 fixation increase (and is N* correctly simulated) when dust deposition is increased and P remineralization lessened a bit (i.e. is increasing P remineralization 2x the only way to get the high N2 fixation rates and correct N*?)

6. The caption for table 1 and the legend for figure 1 are mixed up and should be switched.

7. Figure 6 has different labels on the two color scales, but I assume they should be the same (both PO4)

8. Fig 9. The color scale for the surface PO4 concentrations are hard to discriminate. It looks like the model overestimates by almost a factor of 10 in some places in the surface. Can the color scale be expanded for the lower concentrations?

9. Figure 7 and 8–the figures indicate in the Pacific the phytoplankton are P limited and diazotrophs are NFe co-limited. I suspect this part of the figure is west of the model's boundaries, or is the data correct? Can the authors please use a color that is not on the color scale if it is not model data?

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