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Interactive comment on "Icehouse-greenhouse variations in marine denitrification" *by* T. J. Algeo et al.

Anonymous Referee #1

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General comments:

The manuscript by Algeo et al. presents a synthesized nitrogen isotope (δ15N) record of marine sediments back to 660 Ma. The dataset includes 153 marine units that come from new analyses for this study, the authors' previous work and others' published data. Based on the synthesized record, the authors infer that greenhouse climate mode is characterized by lower δ15N values while higher values in icehouse climates. After discussing various factors that could potentially affect sedimentary δ15N values, including marine nitrogen cycle, diagenesis, terrestrial organic matter source and depositional setting, the authors conclude that the sedimentary δ15N values largely reflect the nitrogen isotopic composition of seawater fixed nitrogen. Using a simple boxing model, the authors suggest a shift from sedimentary denitrification in greenhouse climate to

water-column denitrification in icehouse climate, owing to global sea level changes.

I believe that it is an excellent piece of work. For the first time, I have seen a nice, synthesized δ15N record back to 660 Ma. Due to the nature of this work (sedimentary δ15N values could be complicated by many factors), details need to be further addressed in future studies and potential alternative explanations might also exist. However, the authors appear to have presented a balanced, well-justified view. The authors provide a first-order view of δ15N changes over the last 660 Ma, which could be linked to climate variation. I believe that it is an excellent contribution and strongly recommend its publication.

Specific comments:

1. The authors state that the marine nitrogen cycles is "linked to – and possibly a driver of – long-term climate change". It should be all right to state a linkage between the two as shown by the data. However, if the marine nitrogen cycle is possibly a driver of long-term climate change, how could this work, through emitting more N2O (which appears to me to be in an opposite sense), organic carbon deposition or something else? Could the authors elaborate this point a little further? 2. The authors suggest an expanded OMZ during icehouse climate as compared to greenhouse mode and recognize the different behavior of water-column denitrification changes at orbital (glacial-interglacial) vs. tectonic timescales. The authors stated "...repeated shifts in favor of water-column denitrification during the interglacial stages ... have resulted in a sustained shift toward higher seawater δ15N...". How does this work? Obviously, denitrification changes at the two timescales are opposite. The long-term secular changes in seawater could explain time-averaged δ15N, but cannot explain why δ15N increased during interglacial stages.

Interactive comment on Biogeosciences Discuss., 10, 14769, 2013.