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Interactive comment on “Spatial and temporal patterns of CH₄ and N₂O fluxes in terrestrial ecosystems of North America during 1979–2008: application of a global biogeochemistry model” by H. Tian et al.

Anonymous Referee #2

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The manuscript by Tian et al. represents a well-written paper regarding a continental analysis of how CH₄ and N₂O fluxes vary in space and time for North America. I think this is a worthy attempt at a large goal, and I enjoyed multiple aspects of the manuscript. However, I feel that there are a variety of changes that should be made to enhance the clarity and utility of the paper. In particular, I feel that a more in depth discussion of (1) the information that went into the model and (2) possible controlling factors behind the observed patterns is warranted. Please find my general and specific comments below. General comments Page 2836, lines 24-25: You talk about compar-

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isons being made between modeled results and a variety of field data (e.g. from CERN and LTER) but you do not discuss these further. Are there comparison that were made at this phase besides the two sites you discuss explicitly? Page 2837, lines 15-16: you say that the DOC is either used as a substrate for methane or that it is oxidized to CO₂, but DOC could also be leached 'out the bottom', stabilized within soil organic matter, or used to form heterotrophic microbial biomass. Does the model not account for these other pathways or is 100% of the DOC in the modeled system converted either to CO₂ or CH₄? Or, do these other pathways not matter, because it is simply based upon a relationship between absolute DOC concentration and CH₄ efflux? Also, how are DOC and N concentrations determined/estimated? Are you using biome/ecosystem definitions to do this? If so, what are the definitions and where are the data coming from? Are you using information from a single site and extrapolating to whole biomes? In your formulas describing the controls over CH₄ and N₂O efflux to the atmosphere there is no term for O₂ availability. Is it because O₂ is unnecessary due to O₂ linkages with soil moisture, or simply that soil moisture vs CH₄ or N₂O relationships are so strong? Different ecosystems with the same soil moisture can have different soil O₂ concentrations (soil texture, root and soil heterotroph respiration, etc can help regulate the relationship between soil moisture and soil O₂), but perhaps at this scale soil O₂ is not required? Page 2843, line 5: you say that you use a Q₁₀ of 2.5, while Huang et al. used a Q₁₀ of 3. Though this seems like a small difference, changing Q₁₀ this amount can have very large effects on the results. Please include the rationale for making this change. I find it interesting that Mexico accounts for so little of the CH₄ flux but maintains a significant proportion of the N₂O flux. I think this decoupling is worth discussing. In the same vein, I think you should more fully discuss Canada's very large increase in CH₄ efflux. What is causing this? In general, I think a much deeper discussion of the controlling factors over the temporal and spatial patterns observed is needed. This receives little attention in the Discussion, with only a single paragraph that superficially mentions things like ozone and nitrogen input, but a deeper consideration of how these factors are regulating the patterns would be very useful. What is the role of climate

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(discuss Figure 9), of substrate concentration, etc and how do these important controls vary across space and time? Also, Figure 6 suggests notable increases in efflux through time and I would be interested to hear more Discussion about the controlling factors regulating this pattern. In the first panel of Figure 4, you do see spikes in CH4 production, yet in the text you discuss a lack of spikes and fine scale (e.g. hourly) temporal resolution. With that in mind, why do you think you see spikes here? This should be discussed. Specific comments Page 2833, line 2: I would consider changing 'super-high' to something like 'very high'. Page 2833, line 8: put a 'the' before 'scientific community' Page 2835, line 16: when you say 'mineralization/immobilization' do you mean mineralization and immobilization of nutrients? Please be more specific. Page 2846, line 1: do you mean Landsat?

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