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Interactive comment on "Organic nitrogen storage in mineral soil: implications for policy and management" *by* A. H. Bingham and M. F. Cotrufo

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General comments The authors wrote a well written review on the fate of organic nitrogen in soils and elaborate on possible implications of shifting paradigms for policy and management. The focus is on organic nitrogen in mineral natural (non-arable) soils. I enjoyed reading it!

New conceptual models on the fate of organic matter in soils indeed highlight the importance of environmental, rather than molecular controls (varying on spatial and temporal scales), affecting interpretations of organic nitrogen persistence in terrestrial ecosystems. This review fits in a series of recent publications discussing the consequences of these recent insights for both terrestrial and aquatic ecosystems (e.g., Kaiser & Kalb-

itz, 2012; Marin-Spiotta et al, 2014; Schmidt et al., 2011). As such this paper fits well within the scope of SOIL and has the potential to be well cited.

The authors nicely summarized recent findings on SOM processes in soil but the possible implications for policy and management gained less attention. I would recommend that they come up with an improved concept integrating critical loads and nitrogen saturation/ fluxes in response to the abiotic and biotic properties of natural ecosystems. Using the improved concept it would be valuable to see how current and improved management options differ for a few characteristic natural ecosystems. This would strengthen the focus (and relevance) of this paper.

The factors microbial processing, adsorption and spatial separation are now discussed separately, and conceptually visualized as an one-dimensional process (figure 1). In reality, there is interaction among the factors throughout the entire soil profile (see also Kaiser & Kalbitz, 2012 and Marin-Spiotta et al, 2014). In consequence of continuous sorption and precipitation as well as of microbial processing, desorption and dissolution the proportions of more recent plant-derived compounds decrease with soil depth while those of microbial metabolites and aged/ microbial processed plant-derived compounds will increase. Soil organic nitrogen changes accordingly. I would recommend the authors to add one section integrating the relevance of the discussed factors across the soil profile (and extending figure 1).

In addition to this, I would recommend to add estimated pool sizes and fluxes (to integrate the processes in section 2) in order to underpin the message of this paper. Anyway, there are numerous qualitative statements in this paper (largest, significant contribution, minor share, decrease quickly, predominantly composed, is likely to vary widely, higher quality, are found to be more important, etc.) that might gain relevance when they were extended with estimated quantitative information. In particular, when the terminology "chemically labile" is used, please give an estimated turnover time since lability is a very diffuse term for 'labile' compounds with turnover rates from seconds to weeks, months or even years.

The timing issue might be a relevant item to discuss separately: the focus of this paper is on natural ecosystems with limited N inputs. The relevance of either microbiological or chemical processes - and their controlling factors – vary widely on spatial and temporal scales (as stated in 2.1.) and this certainly has consequences for policy and management.

Specific comments Regarding the discussion on ecosystem N saturation: might it be valuable to link evidence from agricultural studies with those mentioned here? Authors state that "many ecosystems have demonstrated an ability to retain most additional N" and conclude that this state is rarely reached and that there is little evidence of an overall capacity for the retention of N. I fully agree that upscaling is problematic and that not all the processes are well understood, but it seems that I have missed some arguments where the authors conclude that "its importance to a long-term ecosystem N retention is likely to be minimal".

Are C inputs only decreased due to N inputs (P601): is there also not an increased aboveground (and belowground) biomass production due to elevated N inputs in natural ecosystems? Is it valuable to elaborate on optimum N input levels here? Please, consider not only inorganic N losses here but also the increased (?) potential of DON leaching after microbial processing.

"An increased understanding of the factors governing N storage will improves model input estimates (P603)". Is it possible to come up with a table showing quantitative information (range) of the SMB elements for a few types of natural ecosystems and how the new insights might change these estimates in response to soil or microbiological properties for example?

"that unless well protected. . .this N can become available again. . .". This almost suggests that intrinsic biodegradability doesn't exist. I agree that chemical bonding and physical protection are more important than usually thought, but the new conceptual models still include a role for intrinsic recalcitrance. It might be valuable to include

insights from aquatic studies here (e.g., Marin-Spiotta et al, 2014)

"Edaphic factors. . .may regulate the flux of N . . ." it is possible to come up with concrete recommendations for policy and management here?

Valuable references Braakhekke et al. (2011) A vertically explicit soil organic matter model, Ecol. Model., 222, 1712–1730, 2011. De Vries et al. (2013) Soil food web properties explain ecosystem services across European land use systems. PNAS. www.pnas.org/cgi/doi/10.1073/pnas.1305198110. Guggenberger & Kaiser (2003) Dissolved organic matter in soil: challenging the paradigm of sorptive preservation. Geoderma 113, 293-310. Kaiser & Kalbitz (2012) Cycling downwards - dissolved organic matter in soils. Soil Biology & Biochemistry. Marin-Spiotta et al. (2014) Paradigm shifts in soil organic matter research affect interpretations of aquatic carbon cycling: transcending disciplinary and ecosystem boundaries. Biogeochemistry. Ros et al. (2009) Extractable and dissolved soil organic nitrogen – a quantitative assessment. Soil Biology & Biochemistry. Wander (2004) Soil Organic Matter Fractions and their relevance to soil function.

Interactive comment on SOIL Discuss., 2, 587, 2015.