Geophysical Research Abstracts
Vol. 20, EGU2018-7033, 2018
EGU General Assembly 2018

Effects of Different Modelling Approaches to Biological Nitrogen Fixation

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Biological nitrogen fixation (BNF) is critical input into natural ecosystems, helping sustain new growth, especially in an atmosphere with an increasing concentration of carbon dioxide. However, the amount of global BNF is unresolved, and estimates vary considerably in how much BNF provides towards the nitrogen required for new net primary productivity (NPP). The majority of models currently use an estimation of BNF based on either NPP or evapotranspiration, following Cleveland et al. 1999. However, new theories are changing our understanding of how BNF works and how it should be modelled. Studies on the carbon costs of nitrogen fixation and uptake, the influence of mycorrhizal fungi type, the role of free-living rather than symbiotic nitrogen fixers, and others, are now showing the excessive simplicity of current BNF modelling techniques. A comparison of modelling approaches, including new and old methods, is essential to understand better which gives results most consistent with global measurements, and is feasible in complexity.

Using JULES model output and measured values where possible, we assess on a macro scale different BNF modelling methods. We use a variety of modelling methods to estimate nitrogen fixation, including using evapotranspiration, NPP, mycorrhizal fungi type, and symbiotic to free-living fixer ratios, and compare these to available measured estimates. We consider both the global scale and existing site-specific data. We show that there are considerable differences between different BNF modelling approaches and that the choice could have a non-trivial effect on the terrestrial carbon cycle.