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Long-term leaf stoichiometry change under increasing CO_2 and nitrogen deposition in China, evidence from sample data and process-based model

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Leaf stoichiometric homeostasis of plant influences ecosystem structure, functioning and stability through both primary productivity and decomposition process. Long-term CO_2 increase and nitrogen deposition may shift the homeostasis due to imbalances in nutrient availability, leading physiological variation of plants. Many studies confirm that plant stoichiometry and its related physiological processes changed significantly under short-term elevated CO_2 and nitrogen addition experiments. However, few evidences are shown from long-term sampling at large spatial scale of natural ecosystems. In addition, most biogeochemical models assume a constant stoichiometric homeostatic ratio in plant biomass and might cause large bias in plant productivity and thus CO_2 sequestration projection in global change scenarios. In this study, we focus on analyzing leaf stoichiometry change in the past 5 decades in China using 5320 leaf samples and a state-of-art biogeochemical model Community Land Model 5.0 simulation with representation of dynamic plant C:N ratio and carbon cost of plant nitrogen acquisition in plant function types scale. We address the following questions: 1) How do the observed leaf carbon, nitrogen and phosphorus concentrations change in different regions over China under diverse nitrogen deposition (e.g. a 5gN m-2 yr-1 in east China vs 0.1 gN m-2 yr-1 in west China)? 2) What do the data tell about the controlling factor (warming, elevated CO_2, or nitrogen deposition) in leaf stoichiometry change? 3) How CLM5 with dynamic C:N is performing against these large scale measurements? And 4) What is the impact or implication of the representing dynamic C:N ratio to carbon cycle modeling and projection?