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Carbon-nitrogen coupling regulates climate-carbon feedback

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Global climate is sensitive to the atmospheric concentration of carbon dioxide (C_a), and estimates of likely future climate change depend on anthropogenic emissions of carbon dioxide as well as feedbacks between C_a, greenhouse-gas forcing of climate, and carbon storage on land and in the oceans. All coupled climate-carbon cycle modeling studies published to date have found that climate warming driven by greenhouse gas accumulation in the atmosphere causes a release of carbon dioxide from both land and oceans, in a positive feedback loop that enhances radiatively-forced climate change. Previous studies have not included an explicit treatment of nutrient dynamics within the land ecosystem, although the importance of nutrient cycling in regulating carbon fluxes is well documented for the global range of ecosystems. Here we show that including an explicit nitrogen cycle in the land ecosystem component of a coupled climate-carbon cycle model leads to increased carbon storage on land under radiatively-forced climate change, and an overall negative climate-carbon cycle feedback. We found that the primary mechanism responsible for increased land carbon storage is fertilization of plant growth by increased mineralization of nitrogen directly associated with increased decomposition of soil organic matter under a warming climate. Our results demonstrate how a nitrogen-mediated feedback pathway between decomposition and plant growth, ignored in the previous carbon-only model structures, can lead to a sign reversal for the global climate-carbon cycle feedback. Our

results are consistent with recent studies and meta-analyses examining the influence of changing carbon dioxide concentrations and nitrogen supply on vegetation and soil carbon pools. We expect the range in predictions of future climate change to shrink as additional climate-carbon cycle models are modified to include carbon-nitrogen cycle coupling.