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Interactive comment on "A global scale mechanistic model of the photosynthetic capacity" *by* A. A. Ali et al.

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Ali et al. rightly note that most models' way of prescribing photosynthetic capacities (fixed values per plant functional type) is unrealistic. As these capacities are highly plastic, it seems likely that they are tightly controlled and subject to optimal acclimation in some form. This is already assumed in the LPJ model and the models derived from it, including LPJmL, LPJ-GUESS and LPX. Given the widespread availability of photosynthetic trait data (which were scarce when LPJ and other first-generation dynamic global vegetation models were developed), it is certainly timely to use such data to re-examine optimality hypotheses.

Thus, Ali et al. set up an optimality criterion: available leaf N is allocated in such a way as to "maximize the photosynthetic carbon gain". As a result of applying this

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criterion they can account for key features of observed patterns today. But then when applying the optimization principle to a climate-change scenario they find a substantial reduction in future global photosynthesis, compared to a reference simulation in which photosynthetic capacities were held constant.

This does not appear to me to make any sense. How can optimizing carbon gain lead to reduced carbon gain? I have tried to trace how the result arises but I am still not clear, and therefore I would like the authors to clarify the result, and especially to comment on its plausibility.

Based on the text as it is, my understanding is that it may result from the restriction in TRF2 (applied in warmer climates) that optimization of photosynthetic capacity does not continue to temperatures above 33 C (although leaf temperatures higher than this are commonly encountered in tropical forest canopies!) whereas respiration, much of which happens at night, continues to increase with temperature. If this is the explanation, then the result is an artefact of the assumptions of the study: i.e. that photosynthetic acclimation stops at 33 C, while respiration will continue to increase with temperature – even if the additional respiration has no useful function for the plant.

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