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Investigating the controls on Gross Primary Productivity of a high elevation tropical montane cloud forest

M. J. van de Weg (1,2), P. Meir (1), Y. Malhi (3), M. Williams (1), J. Silva-Espejo (4), and J. Grace (1)

(1) School of Geosciences, University of Edinburgh, Edinburgh, UK, (2) The Ecosystem Center, MBL, Woods Hole, MA, USA, (3) Environmental Change Institute, School of Geography and the Environment, University of Oxford, Oxford, UK, (4) Universidad San Antonio Abad del Cusco, Cusco, Peru

Tropical montane cloud forests (TMCF) are a unique, but little understood ecosystem that can be found in tropical mountainous areas around the world. In recent years, the interest in the carbon (C) cycle of TMCFs has increased, especially with regard to possibilities for carbon sequestration and storage practices. Compared with tropical lowland rainforests, these forests have a low aboveground net primary productivity (ANPP), a small standing biomass and a small leaf area index (LAI), while the forests are characterized by the stunted growth form of the trees.

However, estimates of gross primary productivity (GPP) of TMCFs are scarce, and there are uncertainties in what factors are most important in controlling TMCF productivity.

We investigated the controlling factors on GPP in a TMCF in the Andes in south east Peru (13º11'28"S / 71º35'24"W). First, we measured physiological and structural parameters of the vegetation. On a leaf level, the carboxylation efficiency of Rubisco (V_{cmax}) and the electron transport capacity (J_{max}) were as high as those found in tropical lowland forests, but as expected the LAI was smaller. Therefore, in terms of the capacity for TMCF C uptake, the total leaf area is more important in explaining the difference between TMCF GPP and tropical lowland forest GPP, than photosynthetic capacity of the leaf tissue. Furthermore, we used the vegetation parameters, together with meteorological data from the site with a process based simulator (the SPA model) to simulate TMCF GPP and to evaluate the relative importance of the environmental controls on GPP. To our knowledge, this is the first estimate of TMCF GPP that uses parameters and drivers that are derived from the site simulated in the model.

Simulated annual GPP was 16.2 $\pm$ SE 1.6 t C ha^{-1} yr^{-1}, which is about half of the GPP commonly observed in neotropical lowland rainforests. Temperature and, to a lesser extent photosynthetic active radiation (PAR), were the strongest environmental controls on GPP. In contrast, simulated GPP was relatively insensitive to changes in the hydraulic parameters, or observed changes in soil water content. This results is consistent with the observation that (periodic) drought stress is a very unlikely explanation for the lower GPP and NPP of TMCF with respect to lowland tropical rain forests.