# Nitrogen allocation modelling for ecohydrological application: Role of photosynthetic nitrogen in C4 crops under climate change

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## Abstract

Nitrogen is a major constituent of proteins and enzymes that regulates photosynthetic capacity in plants. We use a novel approach for nitrogen allocation (N-allocation) that aims to maximize photosynthesis by allocating nitrogen in plant leaves in two steps: (i). vertical distribution of leaf nitrogen based on an optimal exponential distribution through the vertical canopy structure, and (ii). balancing the leaf-level nitrogen between chlorophyll and rubisco to maintain the photosynthetic rate. We incorporated this N-allocation approach in a multilayer canopy-soil-root system model (MLCan) that was then validated for maize (C4) using observed data at Urbana, Illinois, USA. The model evaluation shows that the N-allocation method established the coupling between ecohydrological processes and soil-nitrogen dynamics. The simulation results indicated the strength of feedback between leaf-level nitrogen and eco-physiological processes. This relationship was affected by changes in the fertilizers and key climatic variables such as $CO_2$, precipitation and ambient temperature. The sensitivity of temperature increased after the implication of the N-allocation method. The vertical profiles of net photosynthetic rate ($A_n$) were resolved based on the vertical distribution of photosynthetic nitrogen. The increase in temperature lowered the vertical gradient of photosynthetic nitrogen and in response, the vertical profile of  was reformed.

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