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Relative Importance of Climate on the Ecosystem Photosynthesis and Transpiration

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The specific characteristics of photosynthesis and transpiration largely result from adaptation and acclimation of vegetation to their environment. We use a simple model with two parameters to explore variation in water use efficiency and explain plant versus climate control on photosynthesis and transpiration.

The data used are from FLUXNET, the global network of tower sites measuring fluxes with the eddy covariance method. We compare sites within comparable forest biomes and in different climate regions. Because eddy covariance observes only net fluxes, the Net Ecosystem Exchange (NEE) is first partitioned into soil respiration and Gross Primary Production (GPP). The resulting GPP and observed latent heat flux (LE) are then used to optimize the combined photosynthesis and transpiration model. This is achieved by optimizing the maximum carboxylation capacity and the marginal cost of plant carbon gain.

The correlation between the observed and calculated values of photosynthesis and transpiration, for the sites within different climate zones, is good with an average r^2 of more than 0.7. The optimized parameters are independent and explain the photosynthesis flux and the ratio between the photosynthesis and transpiration. The water use efficiency has a value between 200 and 850 mol mol^{-1} and the carboxylation capacity a value between 30 and 110 μmol m^{-2} s^{-1}. We will show how the parameters are correlated with several climate variables, such as annual rainfall, temperature and air humidity.