EGU21-6375
https://doi.org/10.5194/egusphere-egu21-6375
EGU General Assembly 2021

Advancing carbon cycle projections with stomatal optimality models linked to plant hydraulics

William Anderegg, Kelly Kerr, John Sperry, Henry Todd, Anna Trugman, Martin Venturas, Yujie Wang, and Nicole Zenes
University of Utah, Salt Lake City, United States of America (anderegg@utah.edu)

Optimal stomatal control models have shown great potential in predicting stomatal behavior and improving carbon cycle modeling. Basic stomatal optimality theory posits that stomatal regulation maximizes the carbon gain relative to a penalty of stomatal opening. Many optimization models take a similar approach to calculate instantaneous carbon gain from stomatal opening. But stomatal optimization models often diverge in how they calculate the corresponding penalty of stomatal opening. We will present our recent work on this penalty function, the conditions that influence the penalty function, and compare and evaluate 10 different optimization models in how they quantify the penalty and how well they predict stomatal responses to the environment. We quantitatively tested different models against multiple leaf gas-exchange datasets. The optimization models with better predictive skills have penalty functions that meet seven key criteria and use fitting parameters that are both few in number and physiology based. The most skilled models are those with a penalty function based on stress-induced hydraulic damage. We conclude by examining the key uncertainties in these optimization models for improving predictions of carbon and water fluxes, as well as demographic rates like drought-induced tree mortality.