ARE YOU INTERESTED IN DEVELOPING CONCEPTS FOR

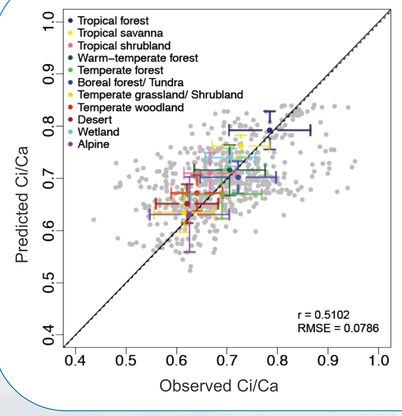
THE NEXT GENERATION DYNAMIC VEGETATION MODELS ?

WE ARE LOOKING FOR CONTRIBUTORS AND IDEAS FOR OUR MULTI-DISCIPLINARY WORKING GROUP AT IIASA

OUR GOAL: BETTER THEORY AND BETTER MODELS BY USING NATURAL SELECTION AND OTHER ORGANIZING PRINCIPLES

The hypothesis

While the versatility of dynamic vegetation models (DVMs) continuously increases, their accuracy suffers from accumulating uncertainty as new processes and parameters are added. We propose that the key to solving this problem lies in a 'missing law' – adaptation and optimization principles rooted in natural selection.



A universal model of photosynthesis? Based on a least cost optimality hypothesis this model predicts photosynthesis and associated leaf-internal to ambient CO_2 partial pressures (Ci/Ca) for multiple biomes with the same parameters. The model is driven by temperature, VPD, and elevation. The figure shows model predictions versus observations from the global δ13C dataset, with mean and standard deviation shown for each biome. The regression line through the origin is imposed as the black solid line; the dashed line is the 1:1 line. *Wang H et al. (2016). A universal model for carbon dioxide uptake by plants. bioRxiv. https://doi.org/10.1101/040246*

Challenges at multiple scales

Can we make a universal model of leaf function and structure (photosynthesis, stomatal conductance, chemical composition, and leaf life-span)?

Which minimum set of traits do we need to model a plant in a DVM?

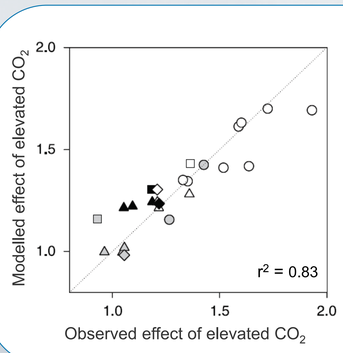
How can we operationalize optimal carbon allocation in a DVM?

How can we model water and nutrient uptake, and the role of plant - soil interactions, such as mycorrhizal and priming strategies?

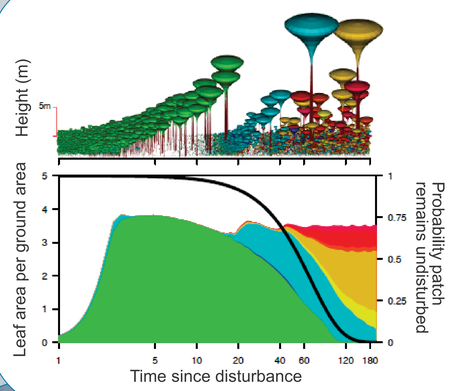
What is the most efficient way to model plant competition in different ecosystems?

How can we model functional diversity in traits and species, its ecological dynamics and evolution?

What are the most efficient ways to model fire, herbivory, insect outbreaks, and forest management?



Are CO_2 effects driven by optimal C and N allocation responses? This optimal allocation model explains whole plant responses to elevated CO_2 in FACE sites based on two primary effects: enhanced photosynthetic nitrogen use efficiency and increased root:leaf ratio. The figure shows elevated/ambient CO_2 values for NPP (open symbols), GPP (black symbols) and LAI (grey symbols) for the FACE sites, POPFACE (circles), Aspen FACE (triangles), Oak ridge (diamonds) and Duke forest (squares). *Franklin O. (2007). Optimal nitrogen allocation controls tree responses to elevated CO_2. New Phytologist 174: 811-822*



A model of trait evolution and species coexistence. Plant species inhabit a metacommunity of patches and differ in two functional traits, leaf mass per area and height at maturation. After a disturbance, vegetation development in a patch follows successional dynamics under height-structured competition for light. *Upper* shows the height of individual plants in a patch as it ages, and *Lower* shows the prevalence of species (left vertical axis and colored areas) as the probability that a patch remains undisturbed decreases (right vertical axis and black line) with an average interval between disturbances of 60 y. *Falster DS et al. (2017). Multitrait successional forest dynamics enable diverse competitive coexistence. PNAS114: E2719-E2728*

The working group

- We aim to develop foundations of a new generation of vegetation models centered on adaptation and optimization principles rooted in natural selection, and other organizing principles
- We strive to reduce complexity and number of parameters: Models should be a simple as possible, but not simpler.
- To facilitate cross-fertilization among disciplines, the group includes modelers and empirical researchers with expertise in: ecophysiology, ecology and evolution, soil processes, mathematics, human impacts, management, and disturbances.
- The project is centered around a series of workshops at IIASA to discuss the science and initiate collaborative research.
- We will produce perspective papers and road maps for model development as well as components for next generation vegetation models.

The organizers

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