Predicting plant water dynamics in Southwestern USA dryland ecosystems using the mechanistic CLASSIC SOX model

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WHY ARE DRYLANDS IMPORTANT?

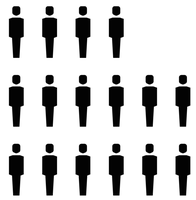
Drylands are sensitive to limited water availability and changes in the water cycle. Better modelling of plant water use can improve our understanding and future predictions for these highly important ecosystems.

Water availability in drylands affects land management and agriculture.

Drylands cover approximately 40% of the earth's terrestrial surface.

Biodiversity in drylands influences biogeochemical cycles.

Dry regions are hot spots for land-atmospheric coupling.

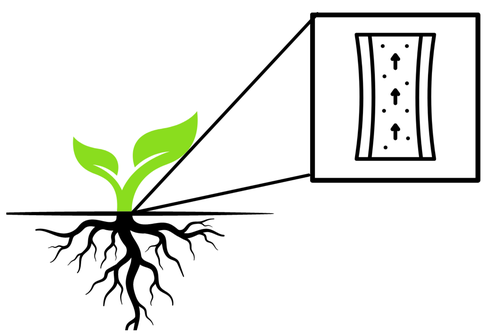


A third of the world's population is supported by drylands.

TYPES OF PLANT WATER MODELS

Water stress and drought conditions are poorly modeled by older models utilizing empirical relationships to represent plant water use in photosynthesis schemes. Recent, more realistic, models employ one of two mechanistic approaches:

1. Stomatal Optimality
A conceptual theory that assumes "optimal" plant behaviour to maximize water use efficiency.

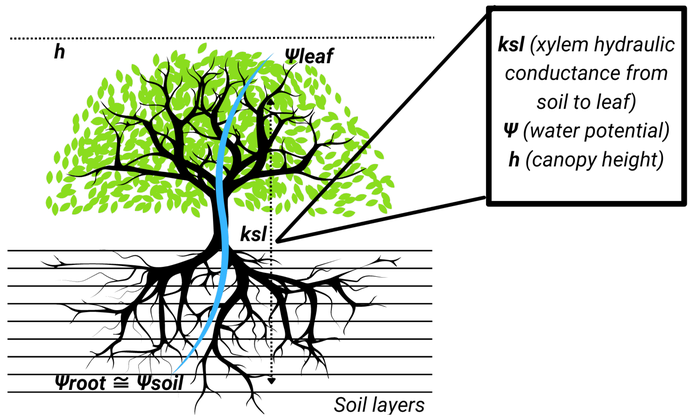


2. Plant Hydraulics
A physical theory based on water potential gradients and structural plant traits involved in water transport from roots to stomata.

How do models predict the future of water availability in drylands?

A NEW APPROACH – CLASSIC SOX

CLASSIC (*Canadian LAnd Surface Scheme Including biogeochemical Cycles*) **SOX** (*Stomatal Optimization based on Xylem hydraulics*) is a combined approach to that incorporates optimality into a plant hydraulics parameterization. SOX is implemented into CLASSIC via the photosynthesis scheme.



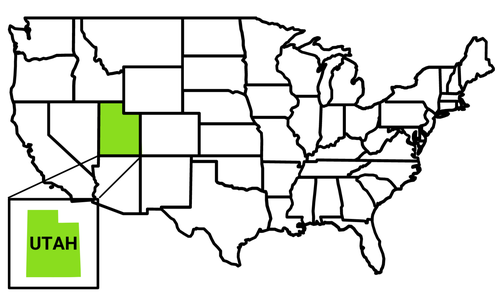
Plant hydraulic traits in SOX give more realistic photosynthesis and water use results.

CLASSIC Model Inputs:

1. Model parameters
2. Atmospheric forcing data
3. Input vegetation data
4. Input soil data
5. Initialization of prognostic variables (*biogeochemical*)

SOX Requirement: Wood density data calculates plant hydraulic traits.

FUTURE WORK



Data from semi-arid Southwestern USA will be used to explore how the new CLASSIC SOX approach can be applied to water-scarce environments.

For my USRI, I have explored the different types of models and data there are that can be used to better understand plant hydrology within drylands.

Future graduate studies in this field will use CLASSIC SOX with dryland data to see whether partitioning between evaporation and transpiration is improved.

REFERENCES:

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2. Sperry, J. S., Venturas, M. D., Anderegg, W. R., Mencuccini, M., Mackay, D. S., Wang, Y., & Love, D. M. (2017). Predicting stomatal responses to the environment from the optimization of photosynthetic gain and hydraulic cost. Plant, cell & environment, 40 (6), 816–830.