Coastal carbon sink dynamics under a low- or no-snow future

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Early Career Award 2021

U.S. DEPARTMENT OF ENERGY | Office of Science

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Improving model projections of coastal water relations under a low- or no-snow future

Motivation:

- Warming and compound extremes
- In tandem, higher ecosystem water use and biomass
- Resulting implications for fire and streamflow remain unknown

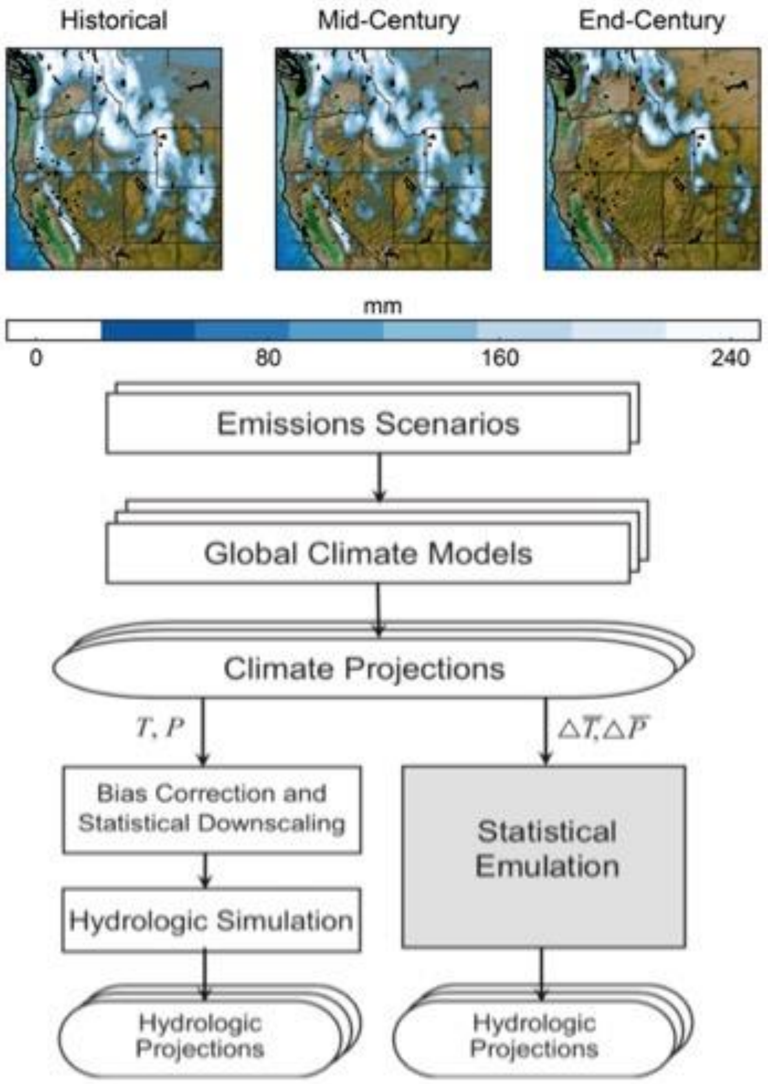
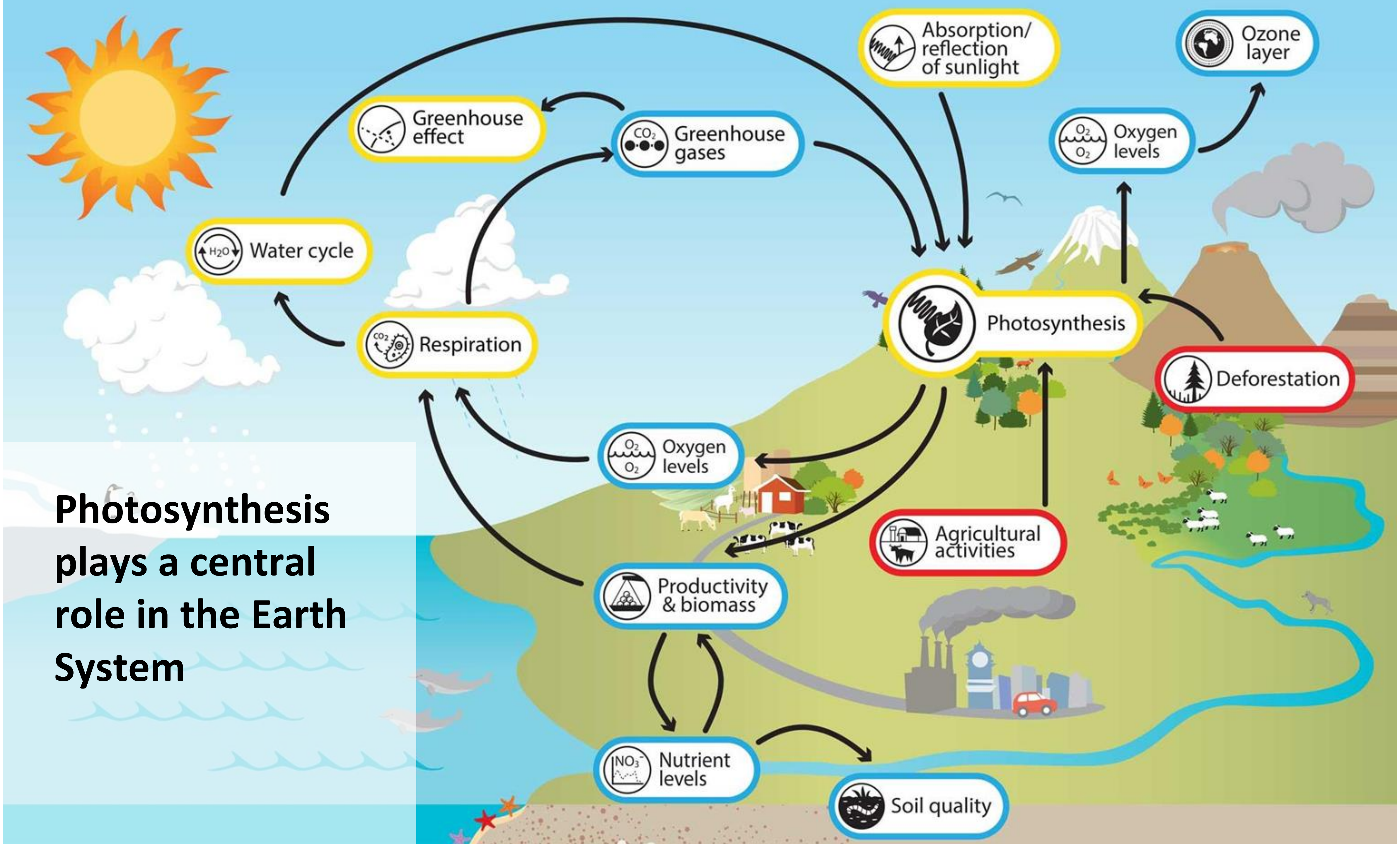


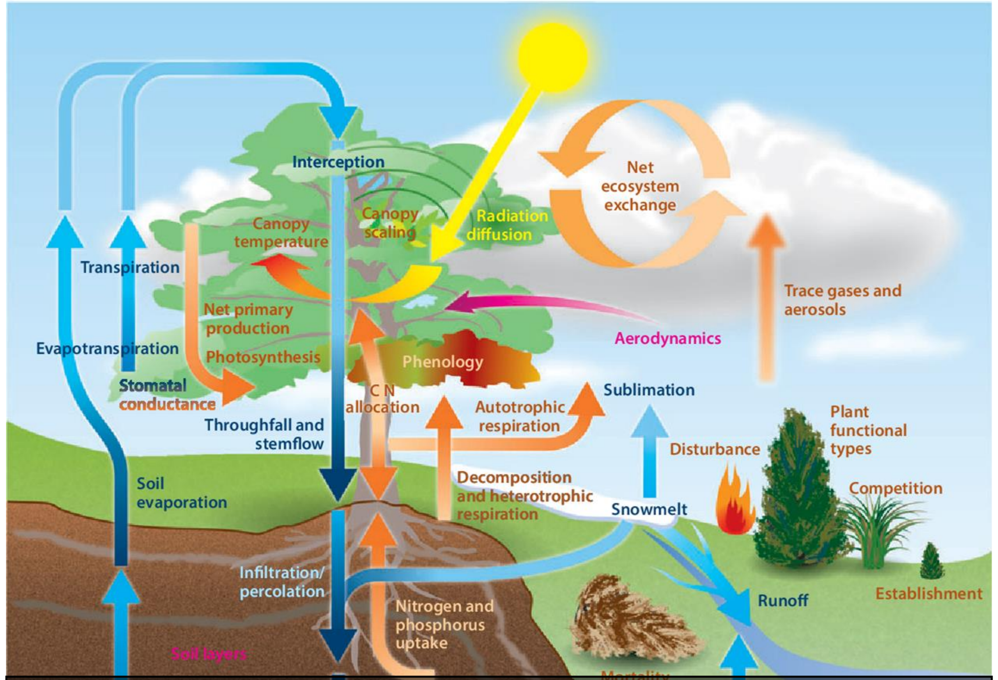
Figure 1 | Snowpack decline, elevated CO2 and increasing extremes such as wildfire and drought impacts on regional hydrology



Photosynthesis plays a central role in the Earth System

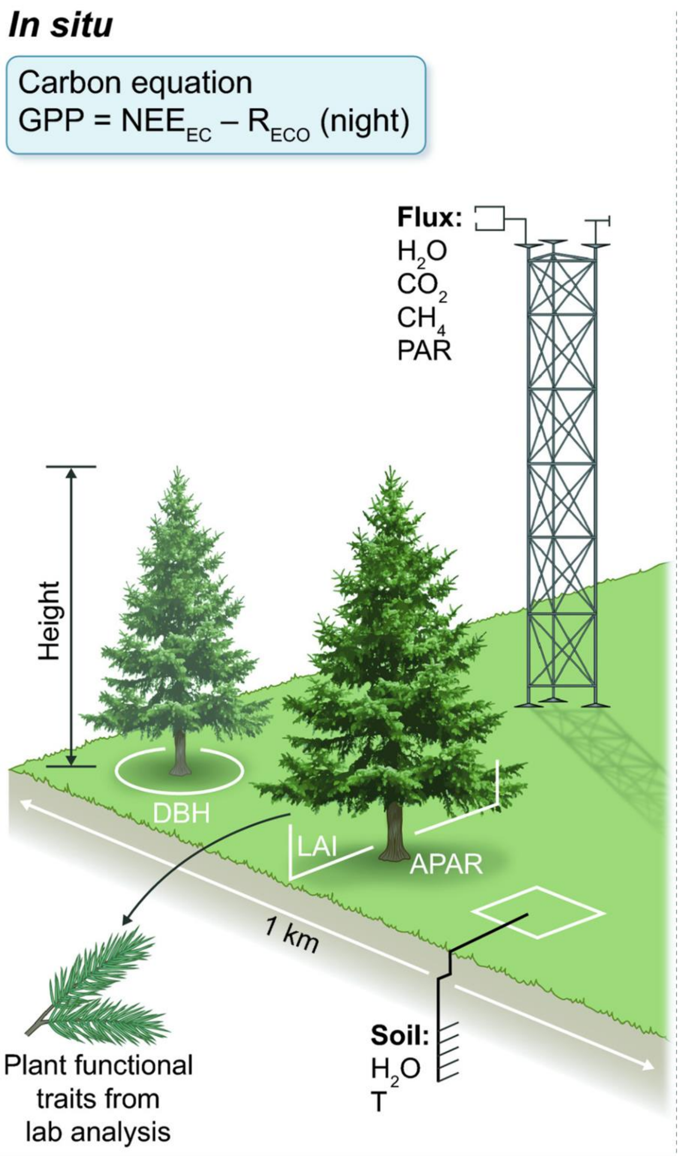
Our understanding of photosynthesis and water use for coastal regions is very limited …

Measurements are local and sparse



Mechanisms are not fully quantified

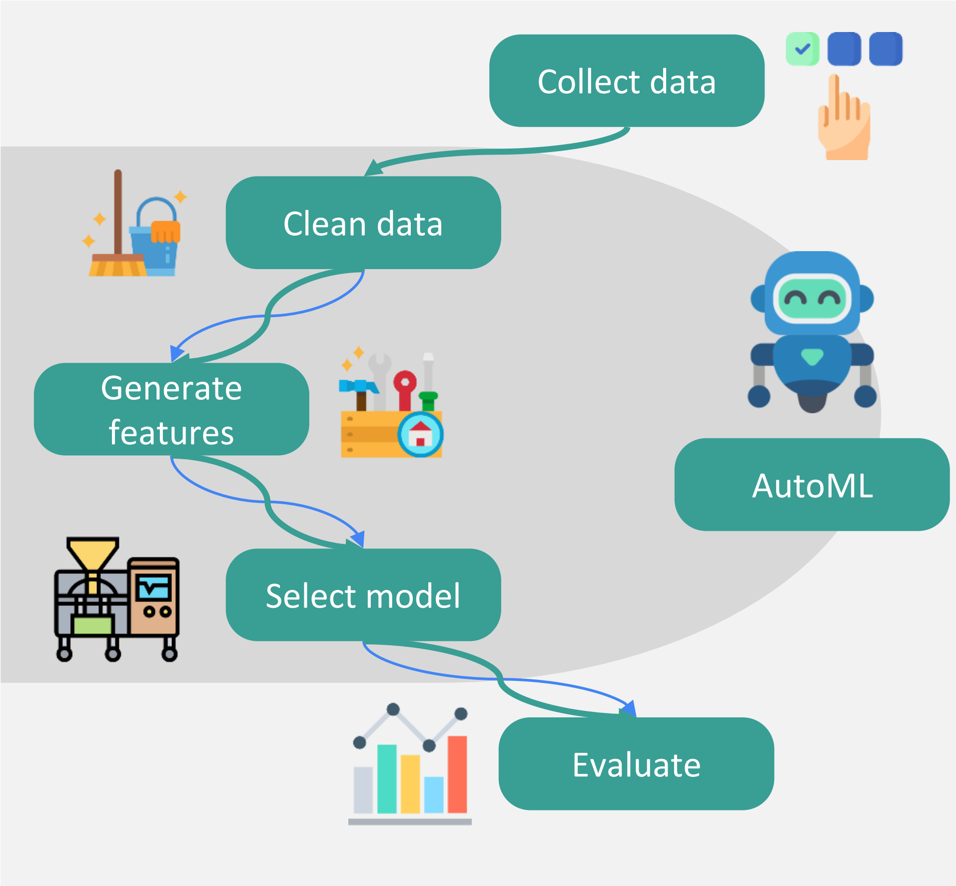
Eddy Covariance Measurements

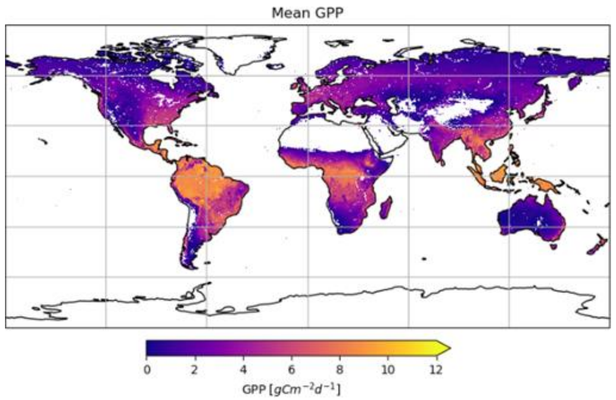


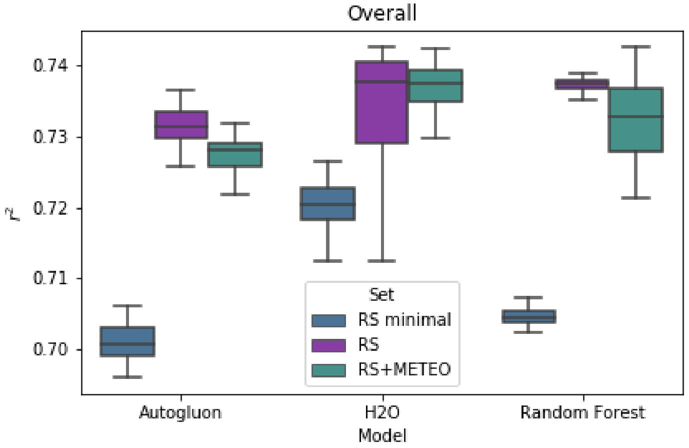
Scaling through ML applied to flux tower obs

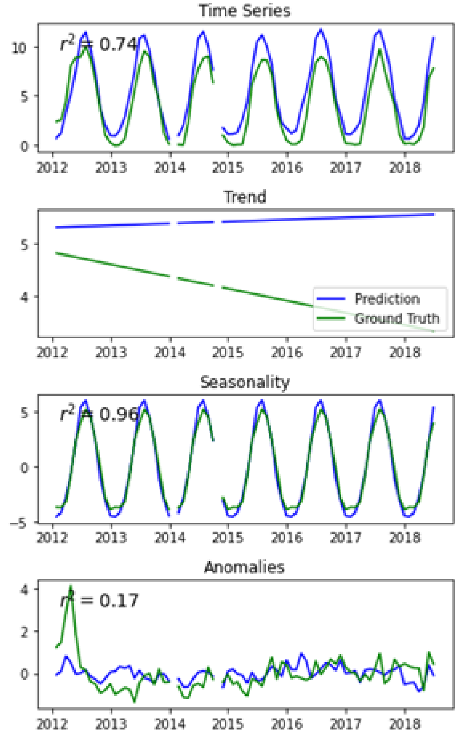
Max Gaber

Evaluating Automated Machine Learning for the Upscaling of Gross Primary Production





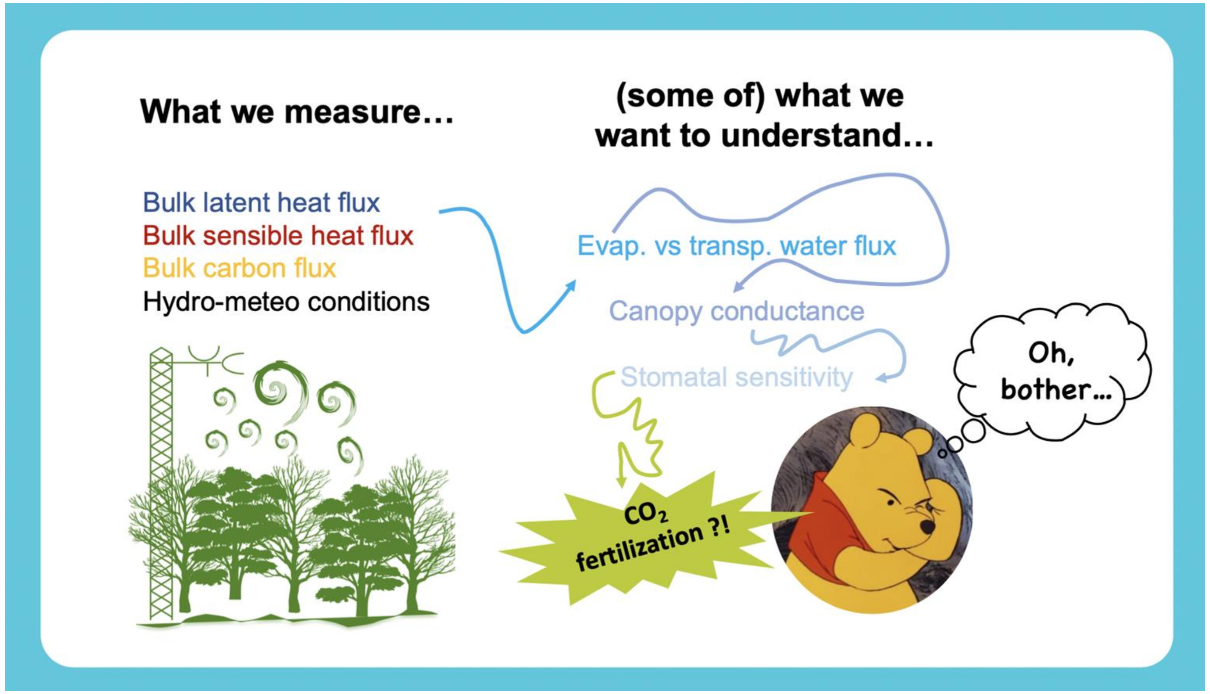




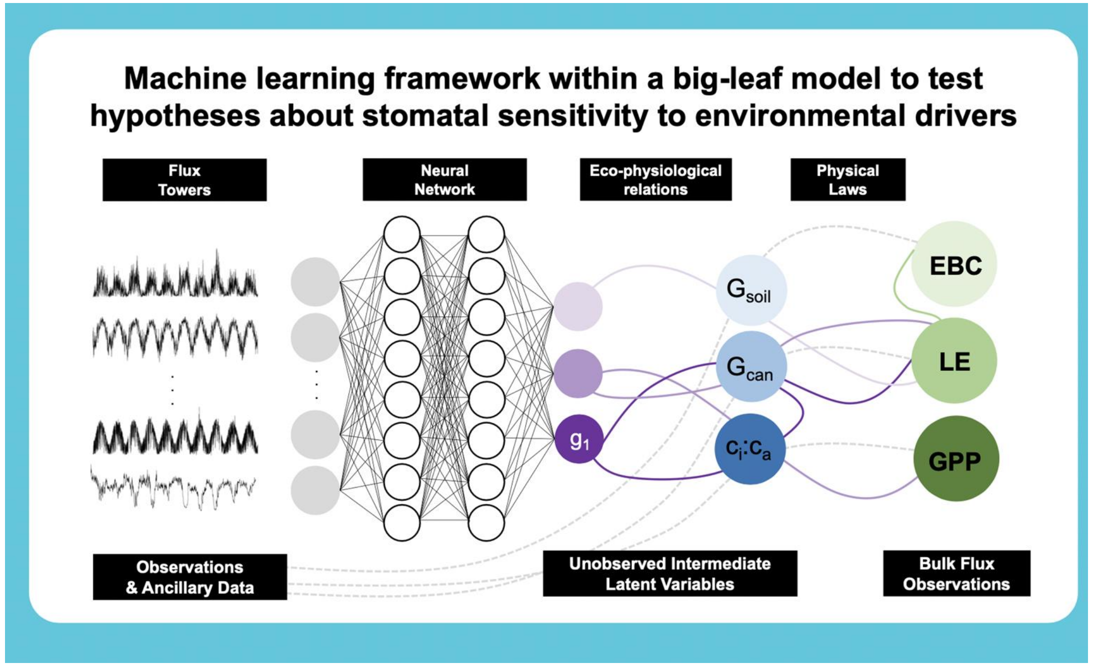
Gaber M, **Kang Y**, Schurgers G, **Keenan TF** (2024) Using automated machine learning for the upscaling of gross primary productivity. *Biogeosciences*, 21, 2447–2472

Scaling through ML applied to flux tower obs

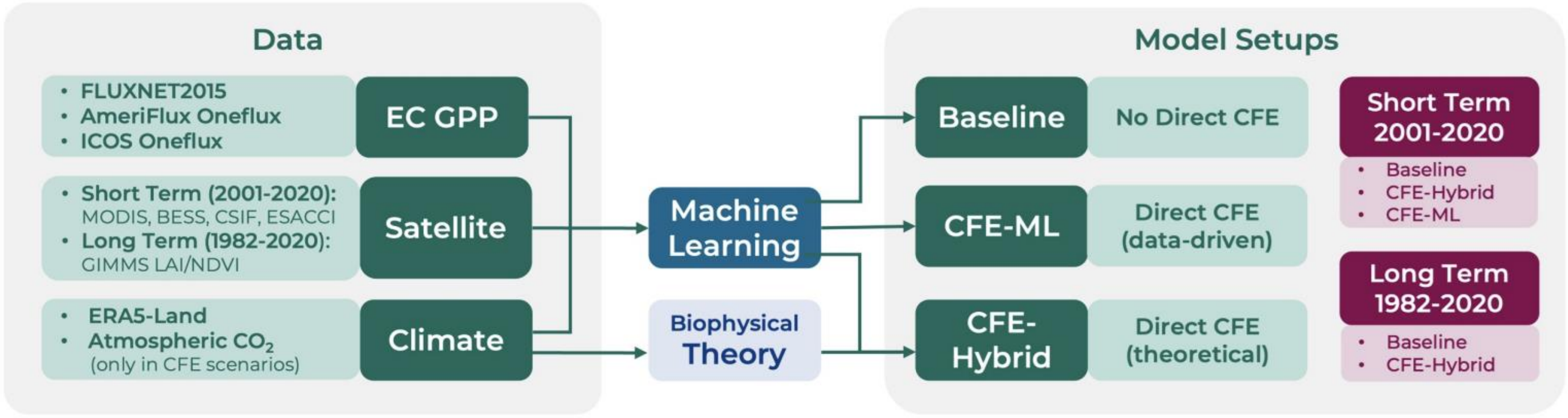
Maoya Bassiouni

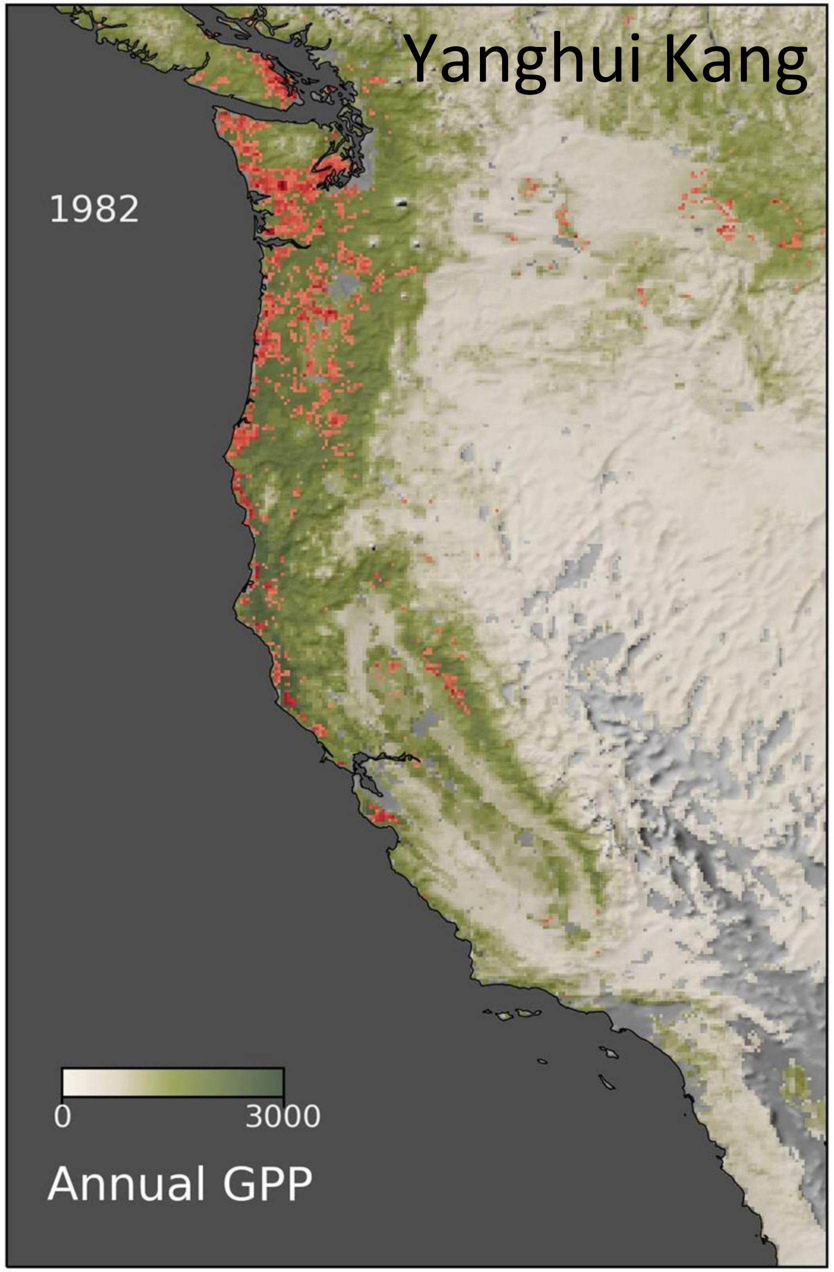


Knowledge-guided Machine Learning



Scaling through ML applied to flux tower obs





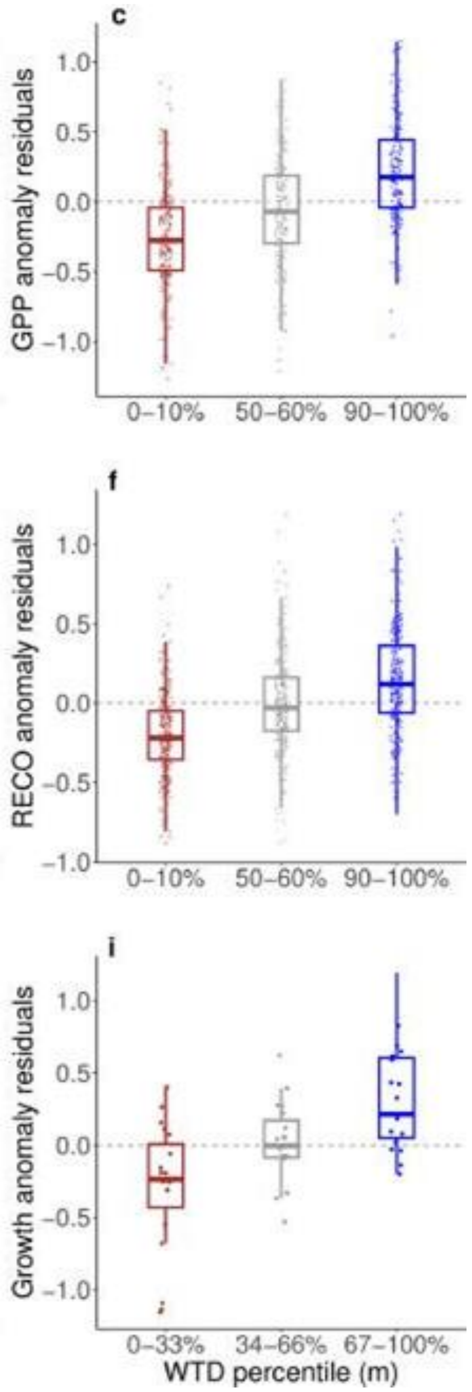
- Dynamic long-term photosynthetic uptake
- Allows for tracking the impact of compound extremes and wildfire
- Directly accounts for the effect of CO2 on photosynthesis
- And changes in regional hydrology / snowpack

Kang et al. 2024 ESSD

But groundwater plays an important role

- Access to groundwater greatly modifies ecosystem sensitivity to compound extremes
- Using two decades of observations, we show far lower impact of extremes when the water table is root accessible

Ruehr et al. 2023 Agricultural and Forest Meteorology



Next steps …

- Using the machine learning models for inference of multi-factor extreme impacts

- Scale the impact of groundwater access on ecosystem responses

- Use ELM-MOSART to relate ecosystem water use to changes in streamflow

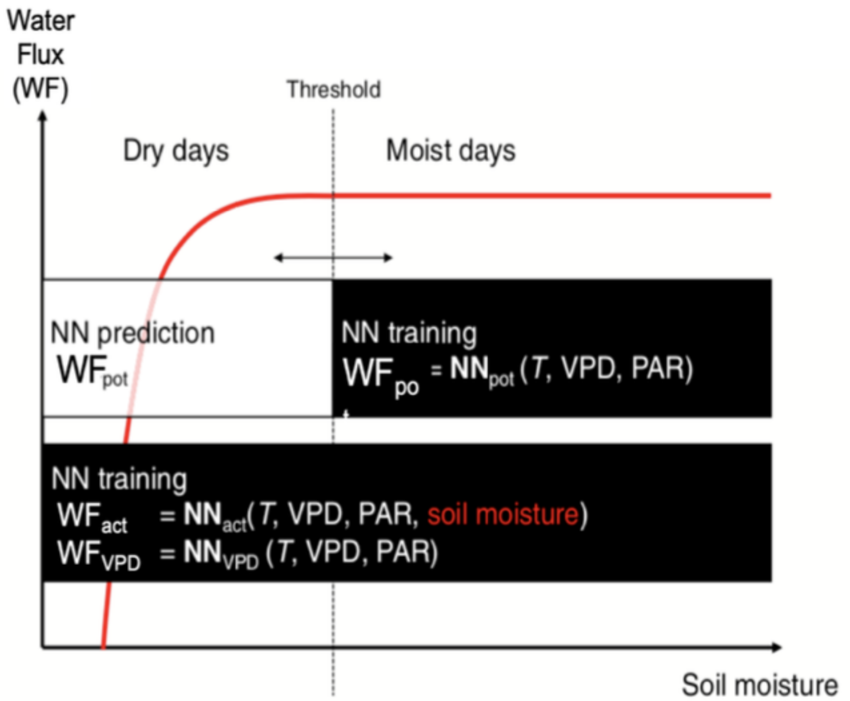


Figure 2 | Illustration of the methods for neural network (NN) training. 'Potential' water flux (WF_{pot}) is predicted using NN models, trained on the empirical relationship between observed WF (WF_{obs}) and its predictors, temperature (T), vapor pressure deficit (VPD) and photosynthetically active radiation (PAR), during days in which soil moisture is relatively high ('moist days'). The threshold between moist and dry days is optimized with respect to NN model performance. 'Actual' WF (WF_{act}) is derived from NNs using all data and with soil moisture as an additional predictor. WF_{VPD} is derived from NNs, trained at all data, but without soil moisture as a predictor. The target water flux can be evapotranspiration, or ET partitioned estimates of transpiration-evaporation.

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