Advancing understanding of plant-drought interactions in North American ecosystems

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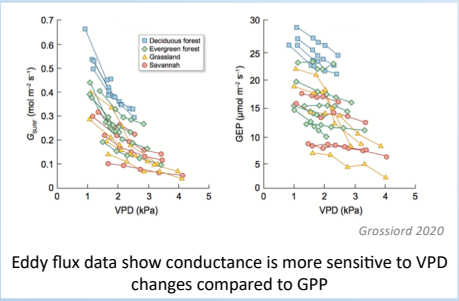
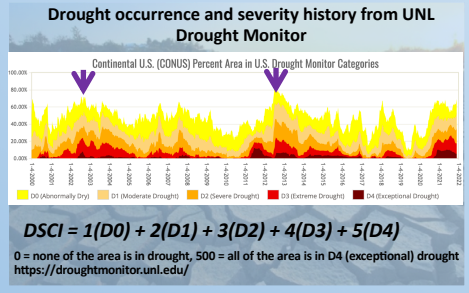
Summary

- Plant-drought interactions can mediate ecosystem responses to drought
- The land surface carbon model SiB4 (Simple Biosphere Model, v4.2) simulates differential response to drought events across different plant types
- Isotope signatures ($^{13}CO2$) can be used to trace plant drought stress responses
- SiB4 simulates increasing water use efficiency in forests from 2000-2020



Eddy flux data show conductance is more sensitive to VPD changes compared to GPP



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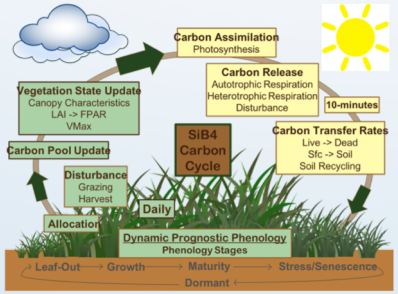
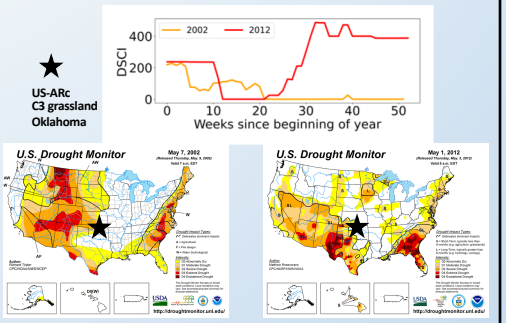
Simple Biosphere Model v4.2

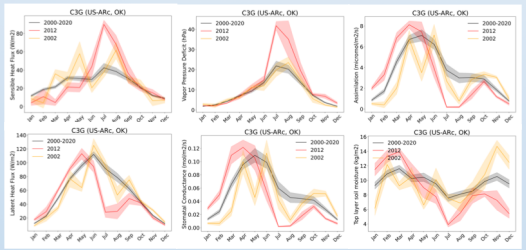


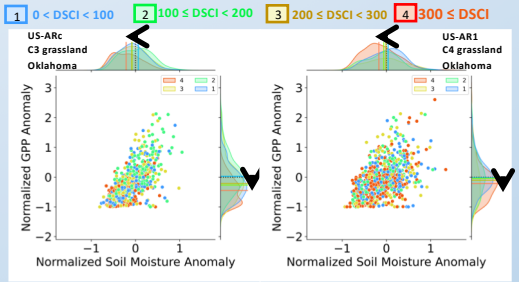
- SiB4 produces prognostic carbon cycle fluxes driven by 0.5-degree MERRA2 reanalysis climatology (Haynes et al., 2019 a,b)
- SiB4 site-level runs were driven by customized vegetation specifications
- Carbon-13 was simulated by implementing a parallel pool structure & fractionation during photosynthesis
- Stomatal conductance is impacted by water stress, so isotopic fractionation should be a tracer for water stress
- Isotope runs were done from 1850-2020 and used atmospheric $\delta^{13}C$ and CO_2 data

UNL Drought Monitor

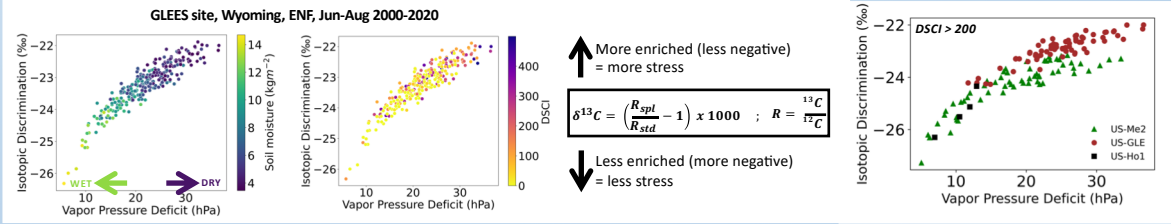


Results

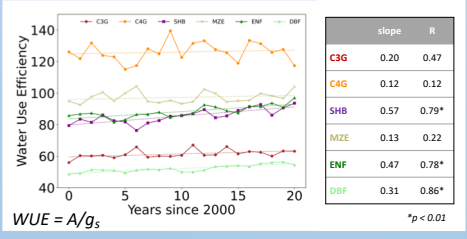




- SiB4 simulates drought severity differences; stomatal control limits soil moisture loss during more severe drought conditions
- Simulated C4 Grasslands show less change in uptake, more resilience to drought

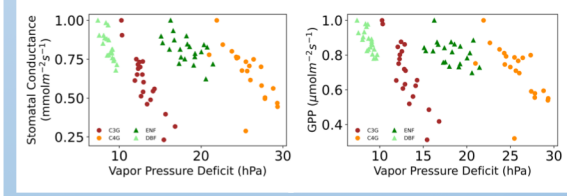


- SiB4 simulates more enriched isotopes for drier soils, higher VPD and more severe drought conditions, dynamic range & magnitude of summertime isotope enrichment differs between climate regions for the same PFT; greater enrichment during drought conditions is mediated by plant stomatal conductance



	slope	R
C3G	0.20	0.47
C4G	0.12	0.12
SHB	0.57	0.79*
MZE	0.13	0.22
ENF	0.47	0.78*
DBF	0.31	0.86*

*p < 0.01



- SiB4 simulates increasing water use efficiency in forests from 2000-2020, GPP decline is less compared to stomatal conductance decline with rising VPD