Global change in the root zone: lessons from soil moisture dynamics in a multifactor climate manipulation experiment

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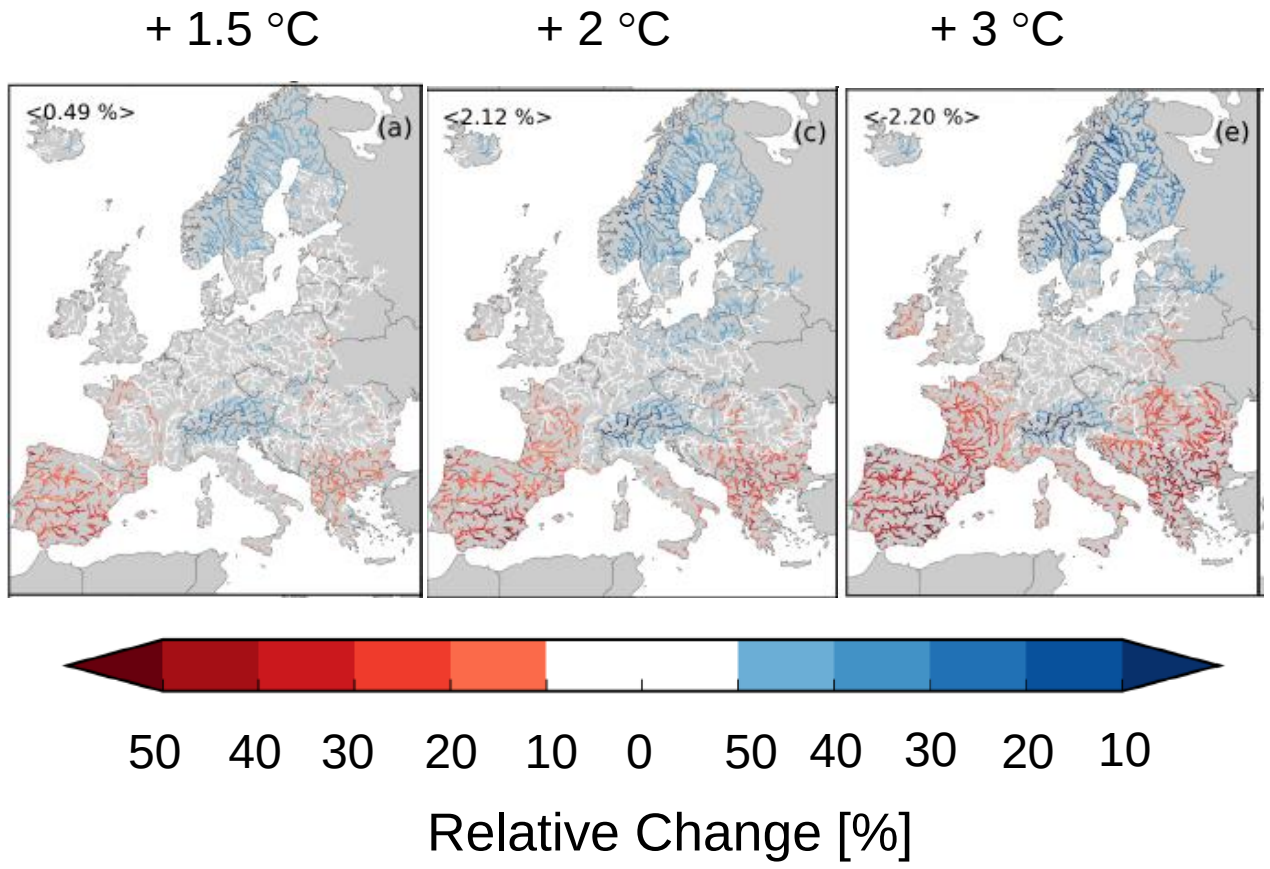
When considered individually, incremental physical alterations to the Earth’s climate have large hydrological repurcussions…

Elevated Temperature



-50% to + 50% in baseflow relative to baseline (1971-2000)!

[Marx et al., 2018]

Elevated CO_2

Rising atmospheric carbon dioxide concentrations may increase streamflow

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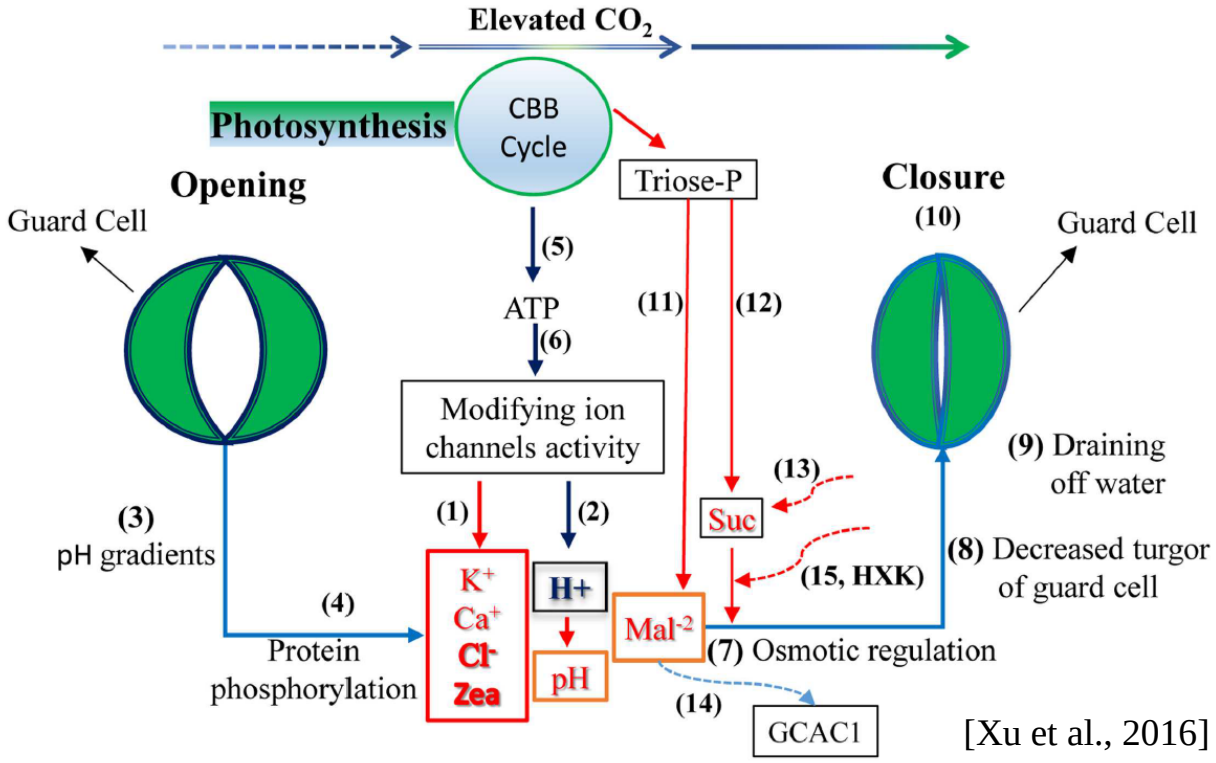
+ 40-60% in runoff by doubling atmospheric carbon

[Idso and Brazel, 1984]

…as elevated atmospheric CO_2 can trigger closing of stomata, and thus a reduction in evapotranspiration

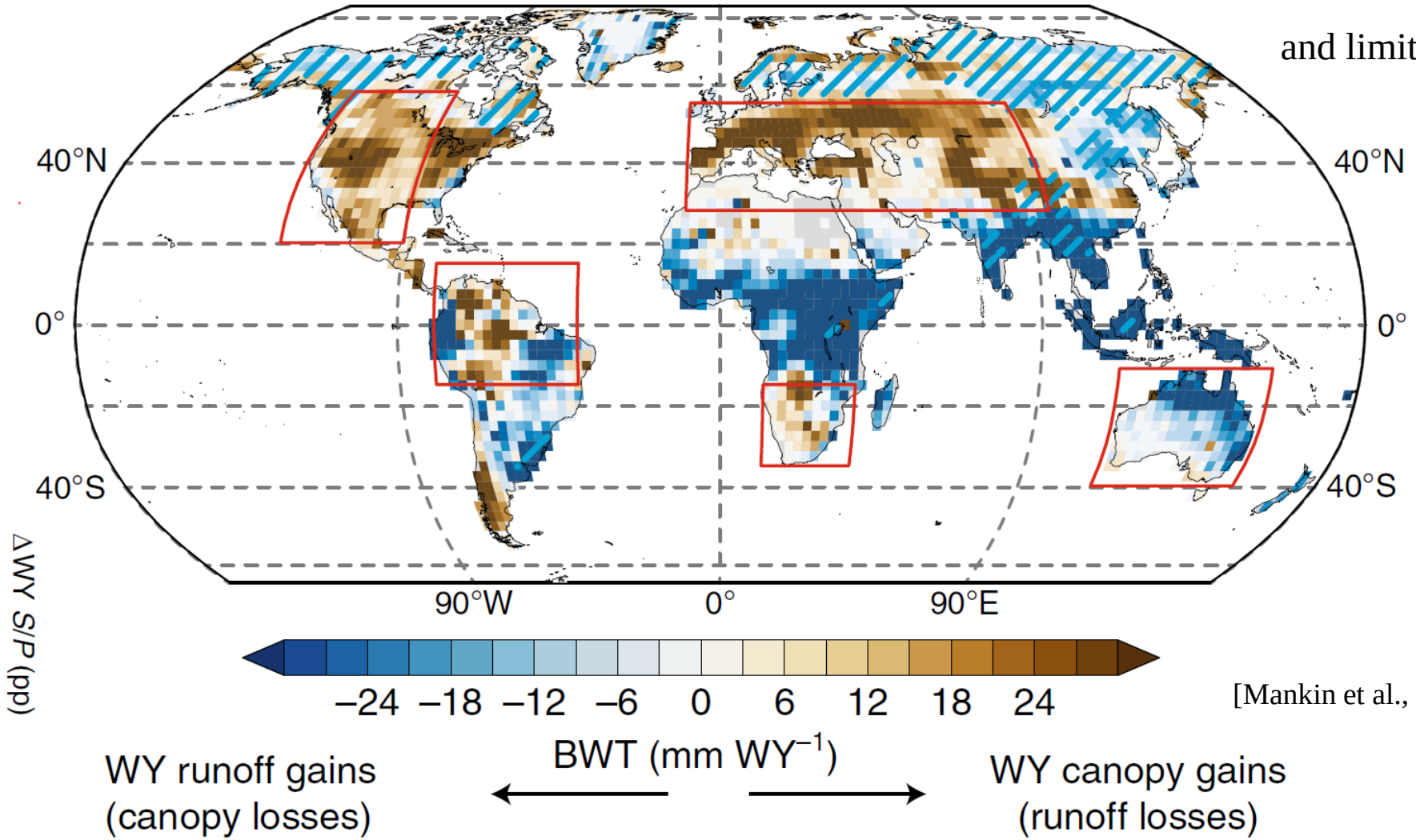


[Xu et al., 2016]

Multifactor modeling scenarios profuce more complex outputs …

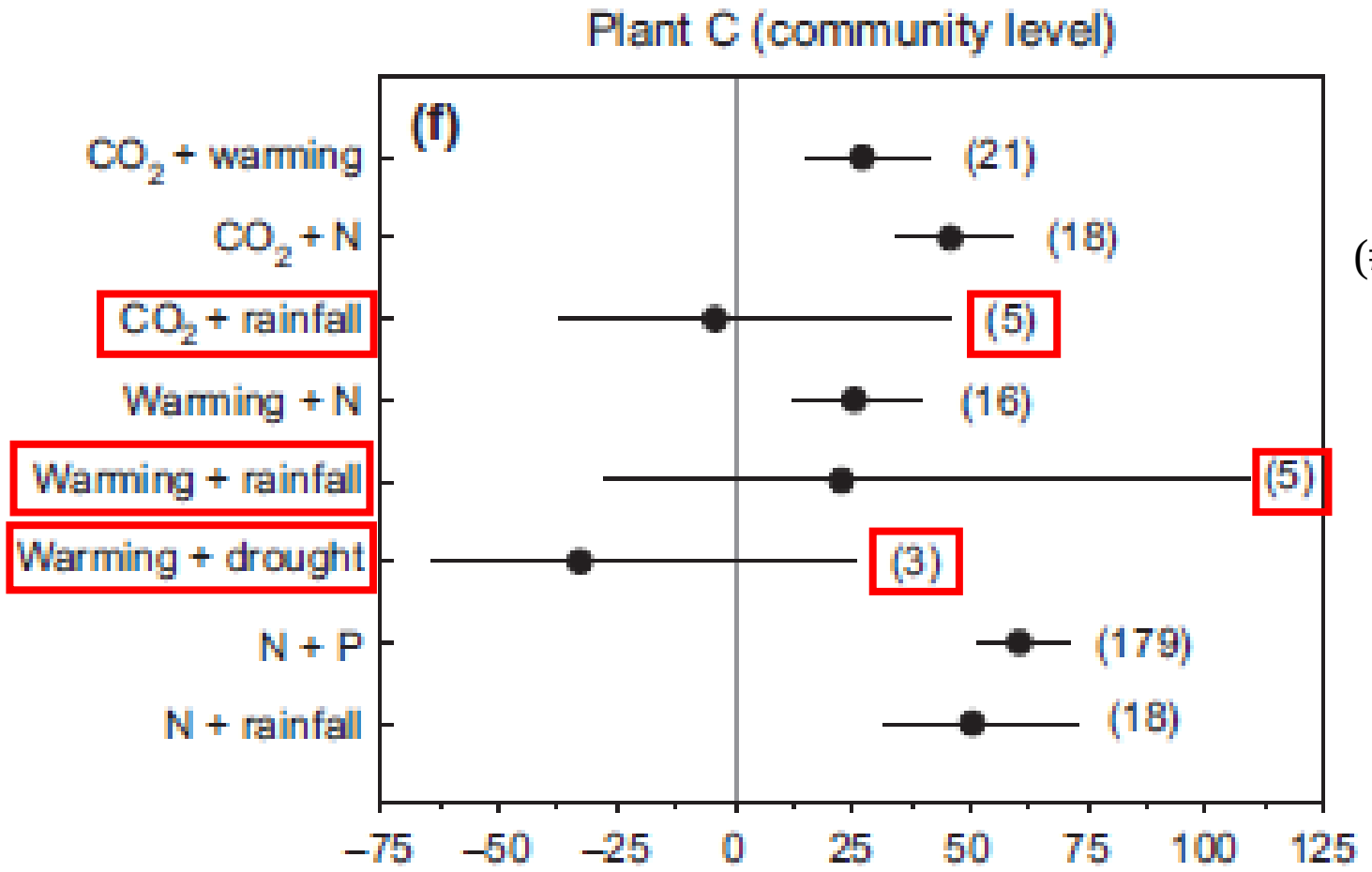
… elevated temperature and atmospheric CO_2 may drive higher plant production ultimately increasing hydrological demands and limiting runoff in the northern hemisphere

Elevated CO_2 and Temperature



[Mankin et al., 2019]

But little experimental evidence of these interaction effects exists …

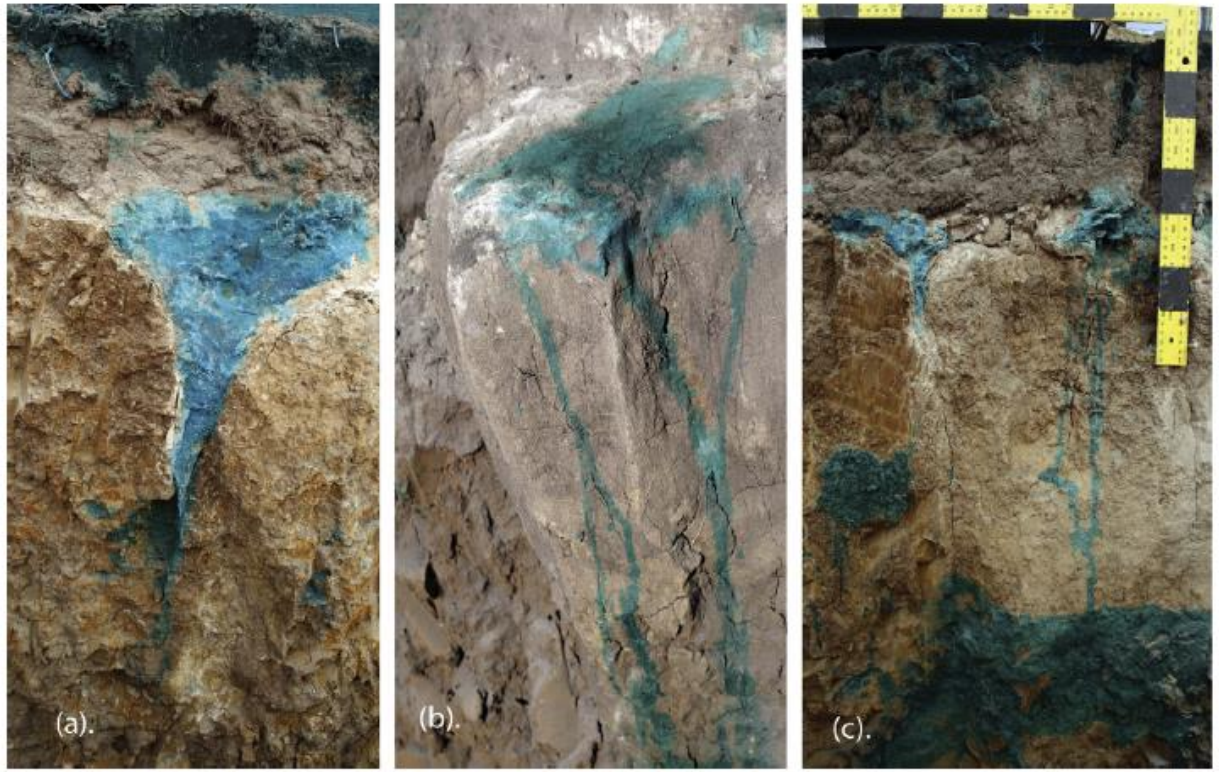


(# of studies available)

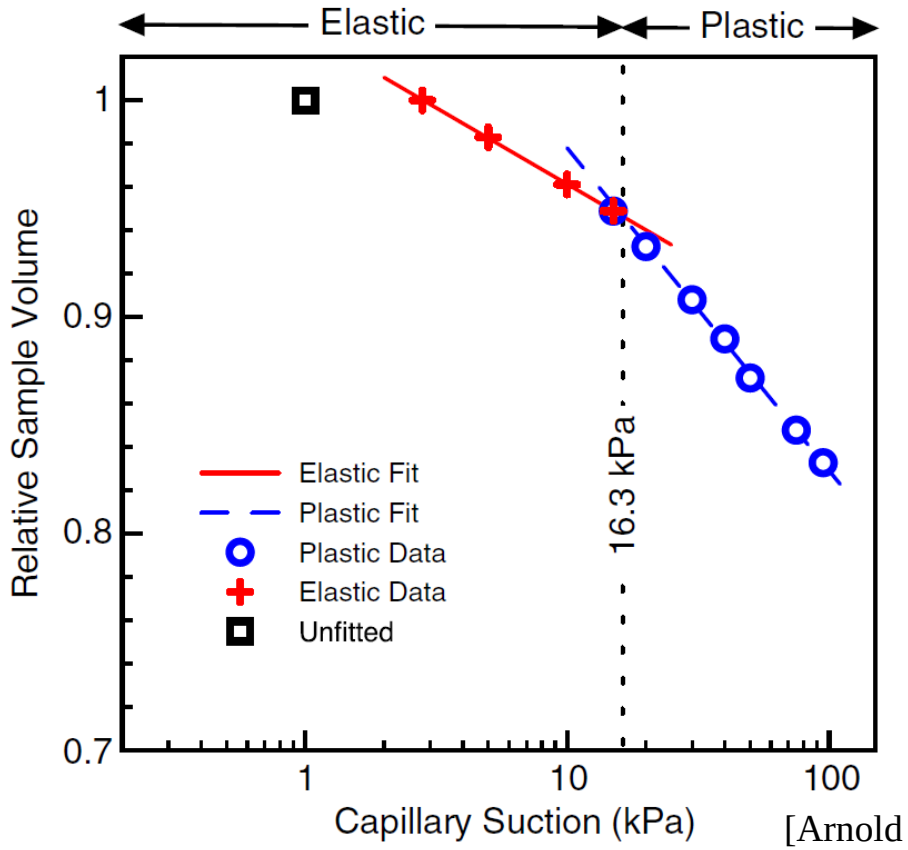
[Yue e tal., 2017]

Ecohydrological implications rarely considered (if ever)

Especially at a process-scale…



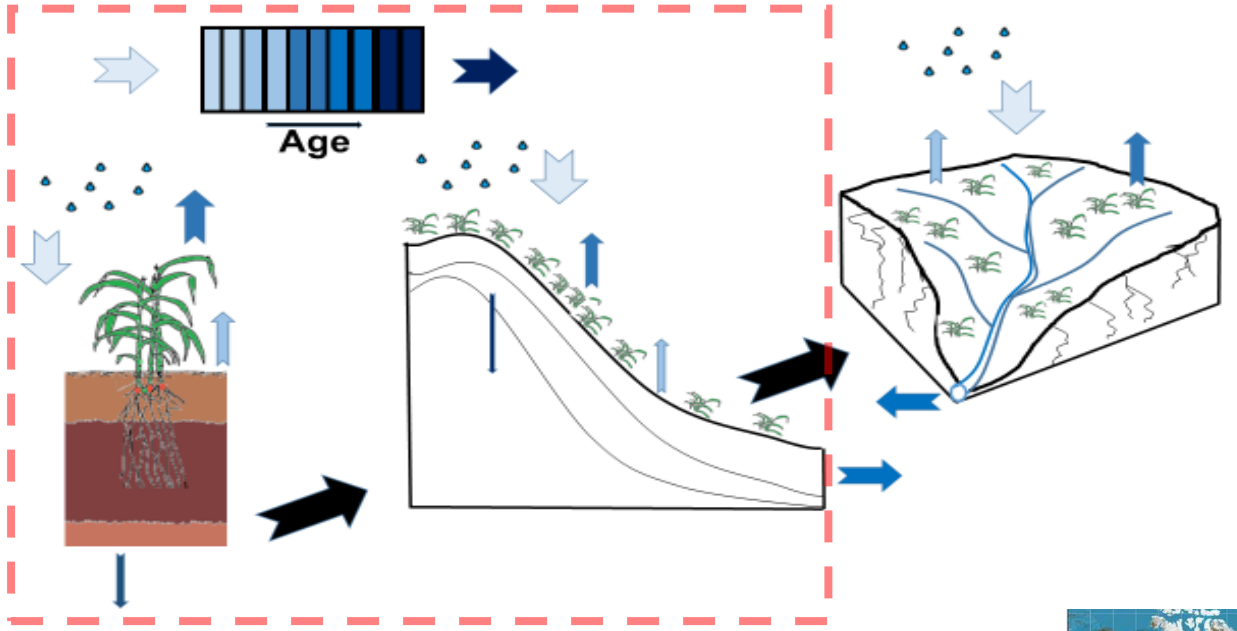
[Hardie et al., 2011]

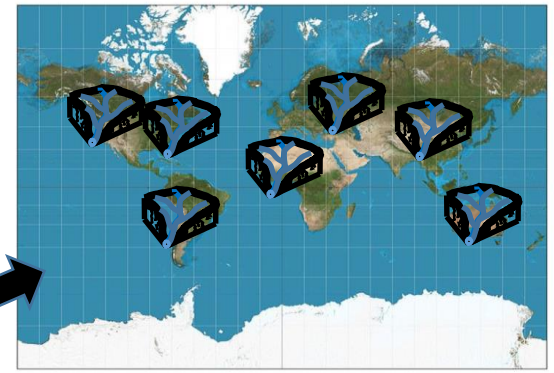


[Arnold et al., 2015]

…where we can observe persistent changes to physical hydrology in the vadose zone (e.g., due to extreme/abnormal drying and wetting cycles altering soil structure)

…thus, it is ***as important*** to study controlled climate manipulation at a small scale, directly …





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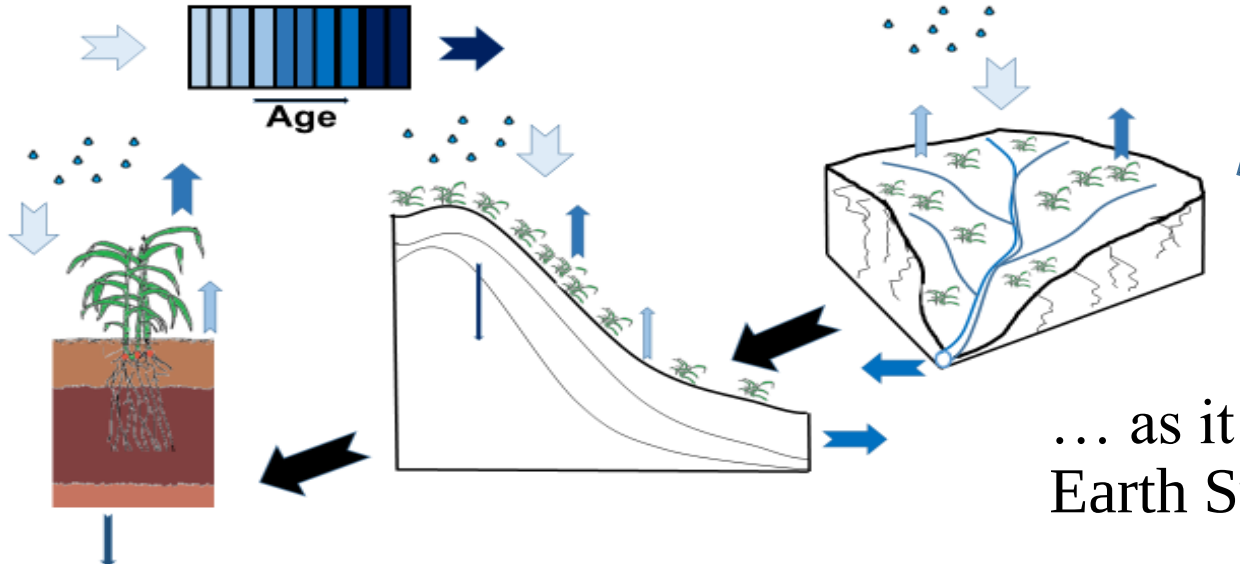
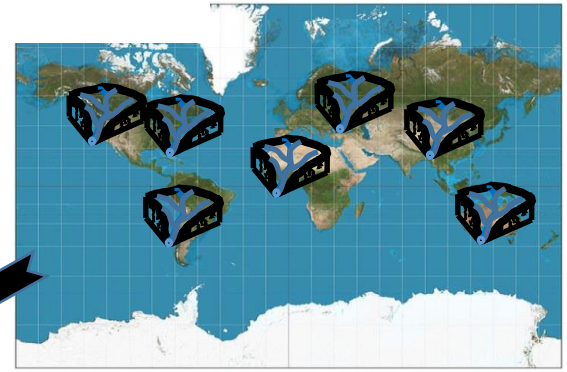
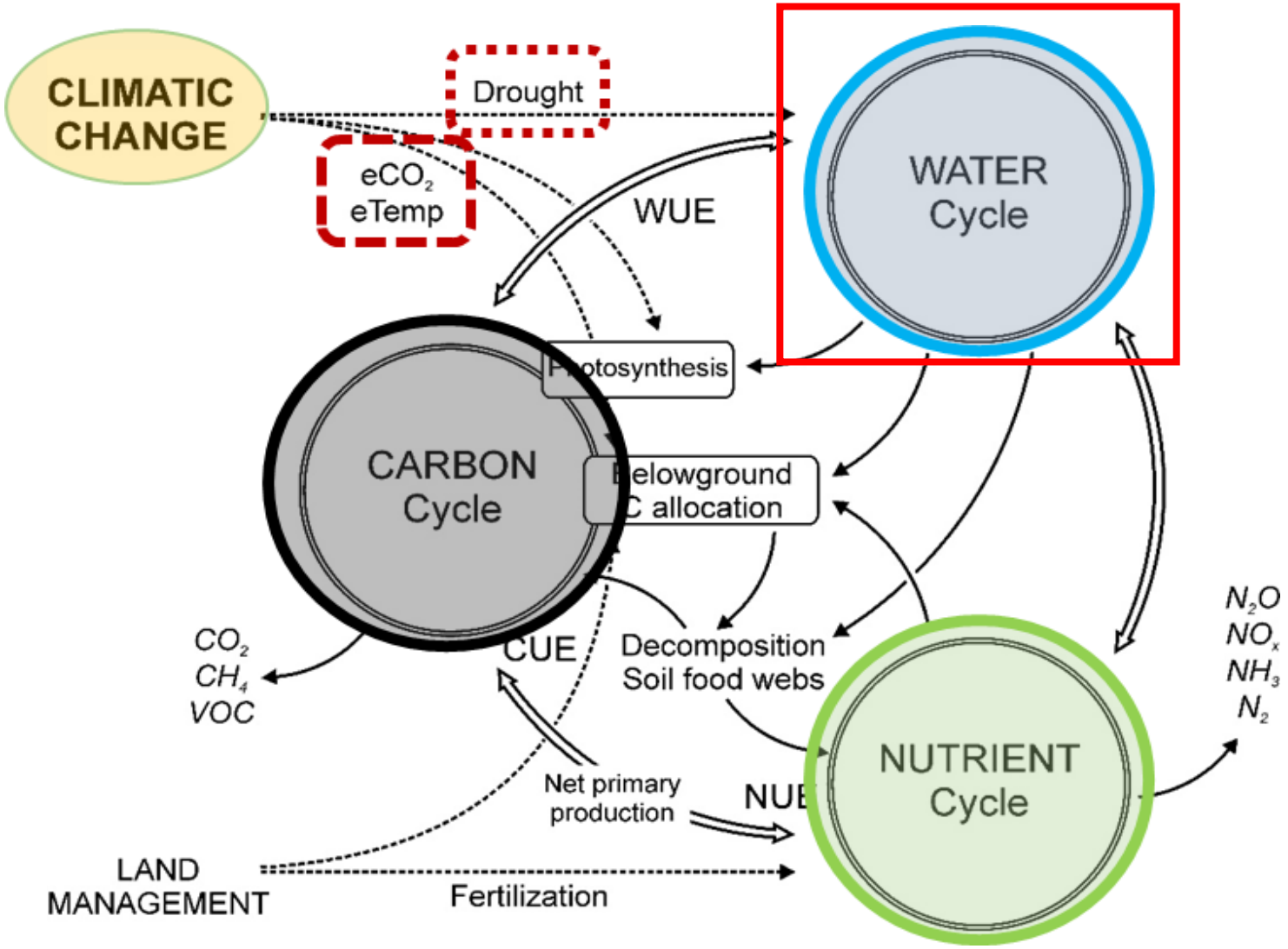
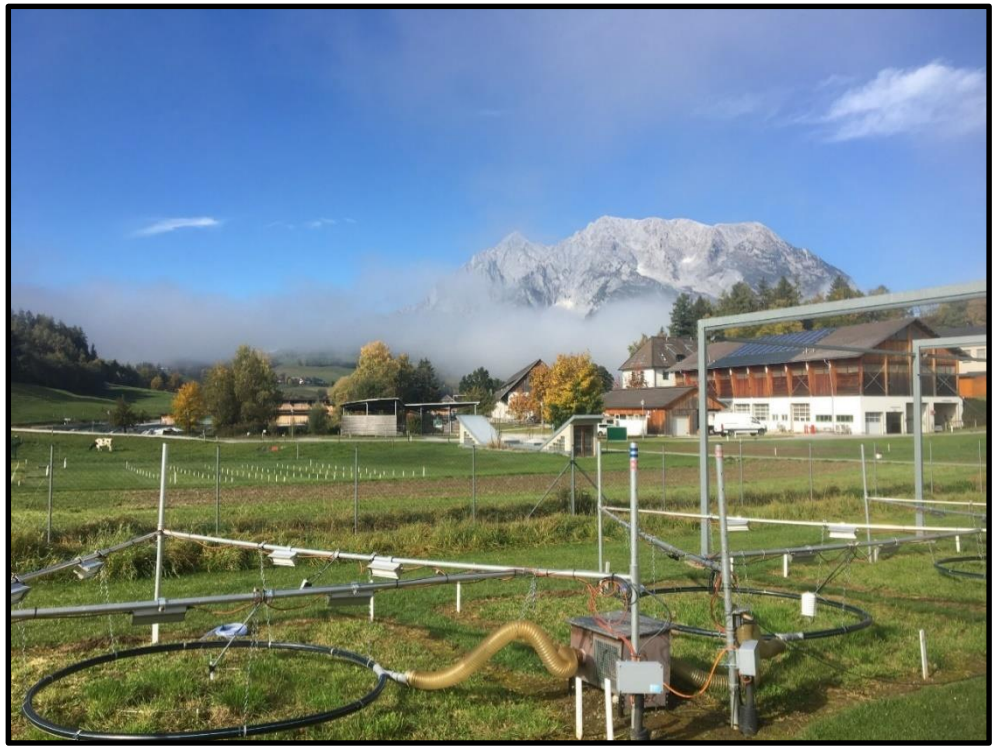




… as it is to extrapolate from less certain global Earth Systems sytheses

ClimGrassHydro

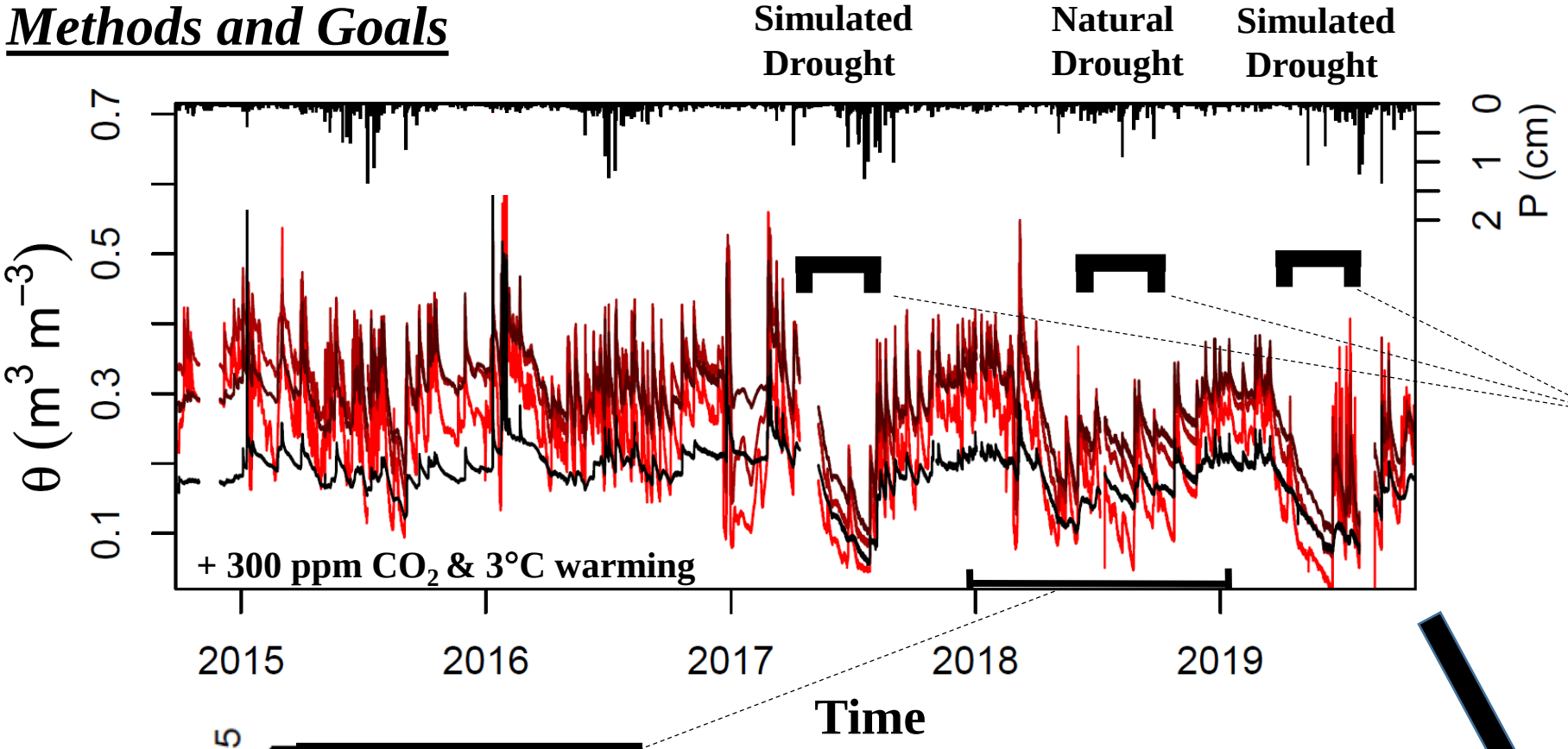




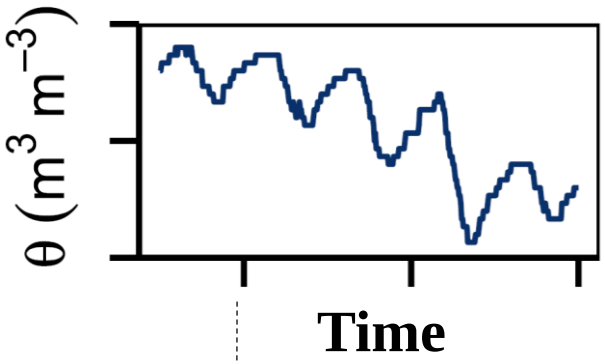
Quantify ***individual*** and ***combined*** effects of climate change (elevated T and CO_2 + drought) on grassland ecohydrology

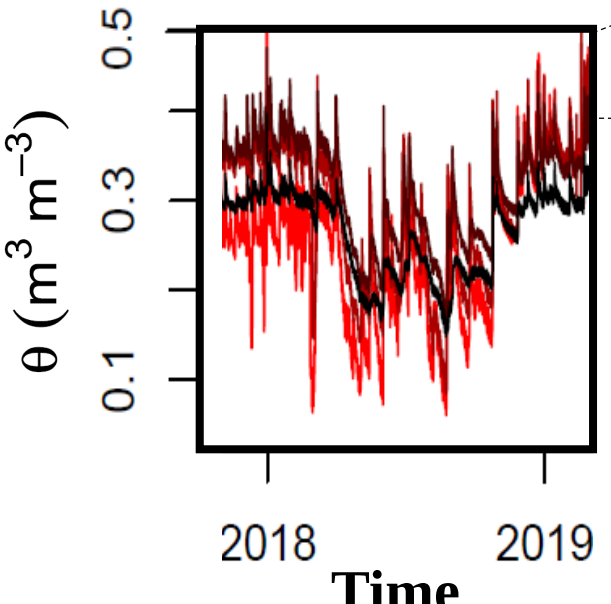
Seeks to…

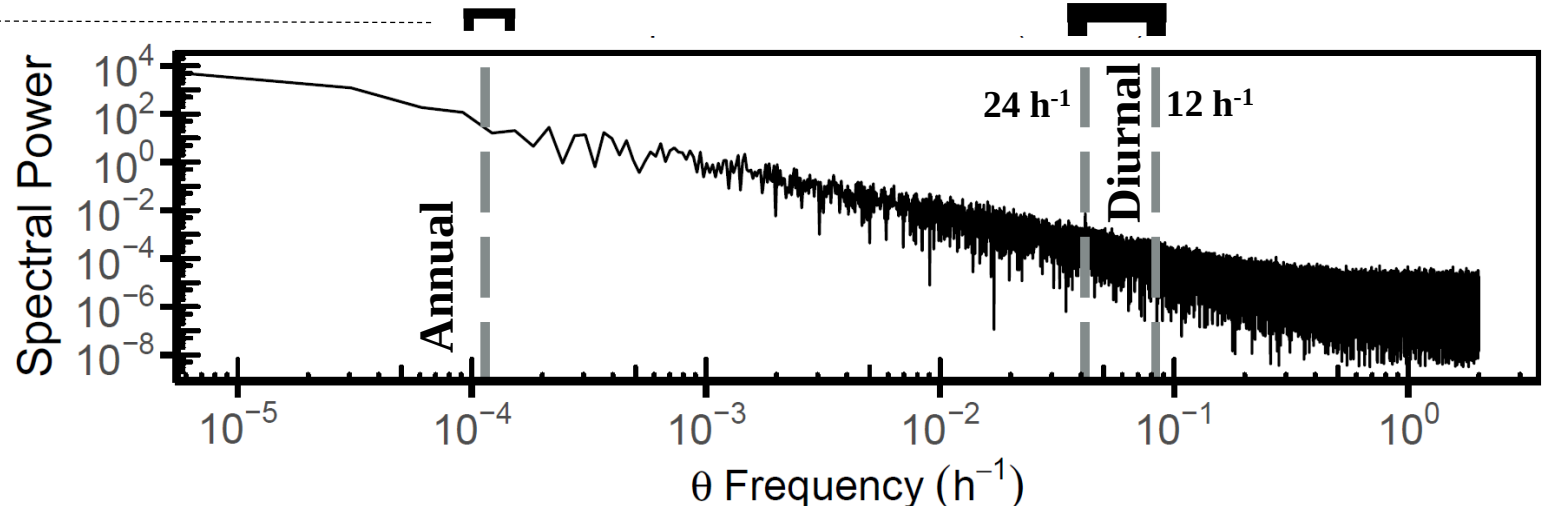
Methods and Goals



Use spectral analyses to understand how Climate Change (individual and combined effects of warming, elevated CO_2, and drought) alters soil moisture (θ) partitioning in the root zone: from 12 h to yearly cycles!

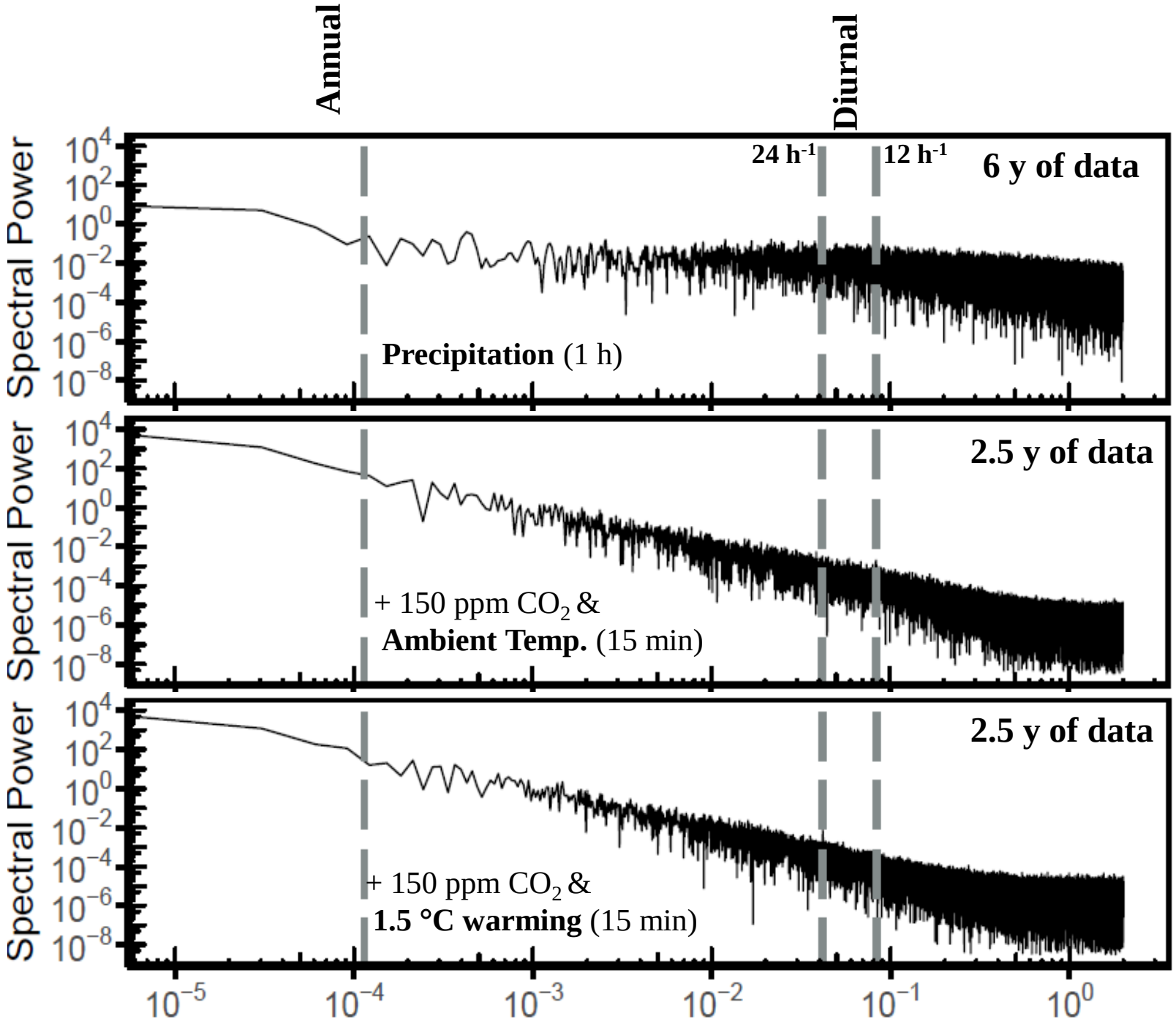






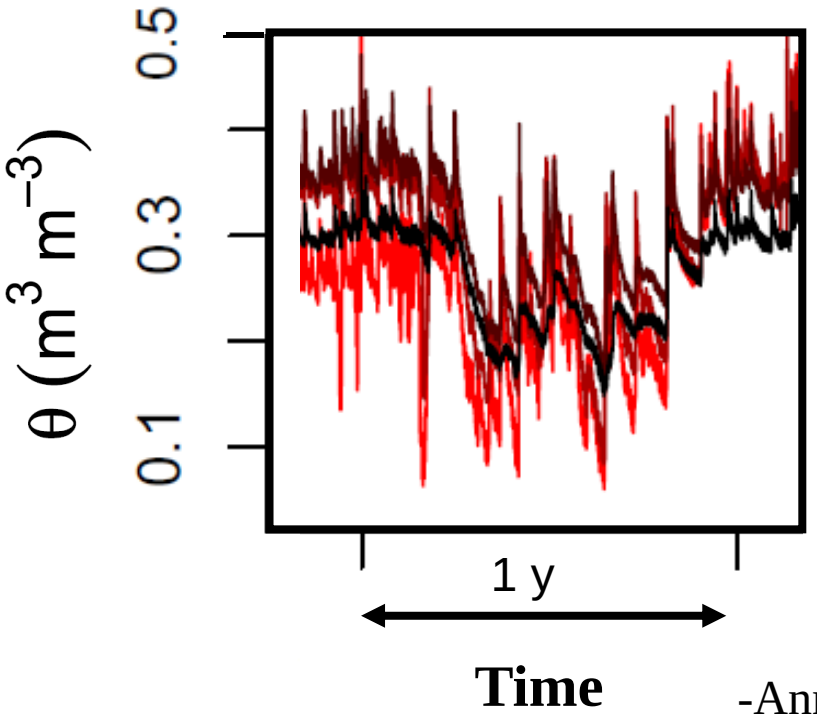
Preliminary Results

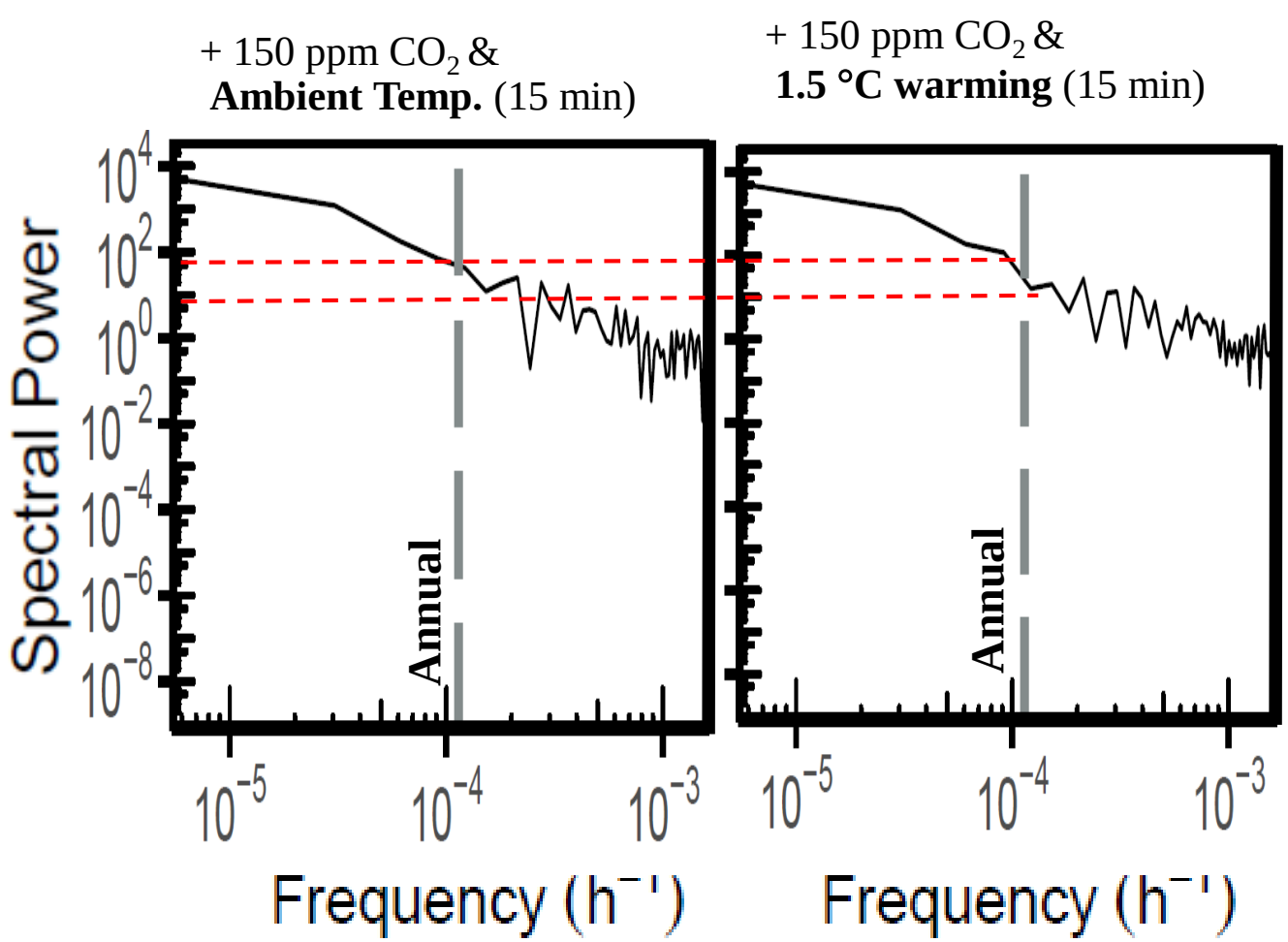
@ 36 cm soil depth



Considering annual fluctuations …

@ 36 cm soil depth





-Annual cycles in soil mosture explain ~ an order of magnitude more variation in root zone moisture fluctuations for + 150 ppm CO_2 & **ambient temperature** compared to those subjected to + 150 ppm CO_2 & **1.5 °C warming**!

-This suggests that the relative importance of seasonal recharge to subsurface moisture partitioning may becomed damped with incremental warming in these mountain grasslands.