Funded by:
Irene Evers' Competitive Undergraduate Research Scholarship
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Advisors:
Kelsey Jencso
Zachary Hoylman

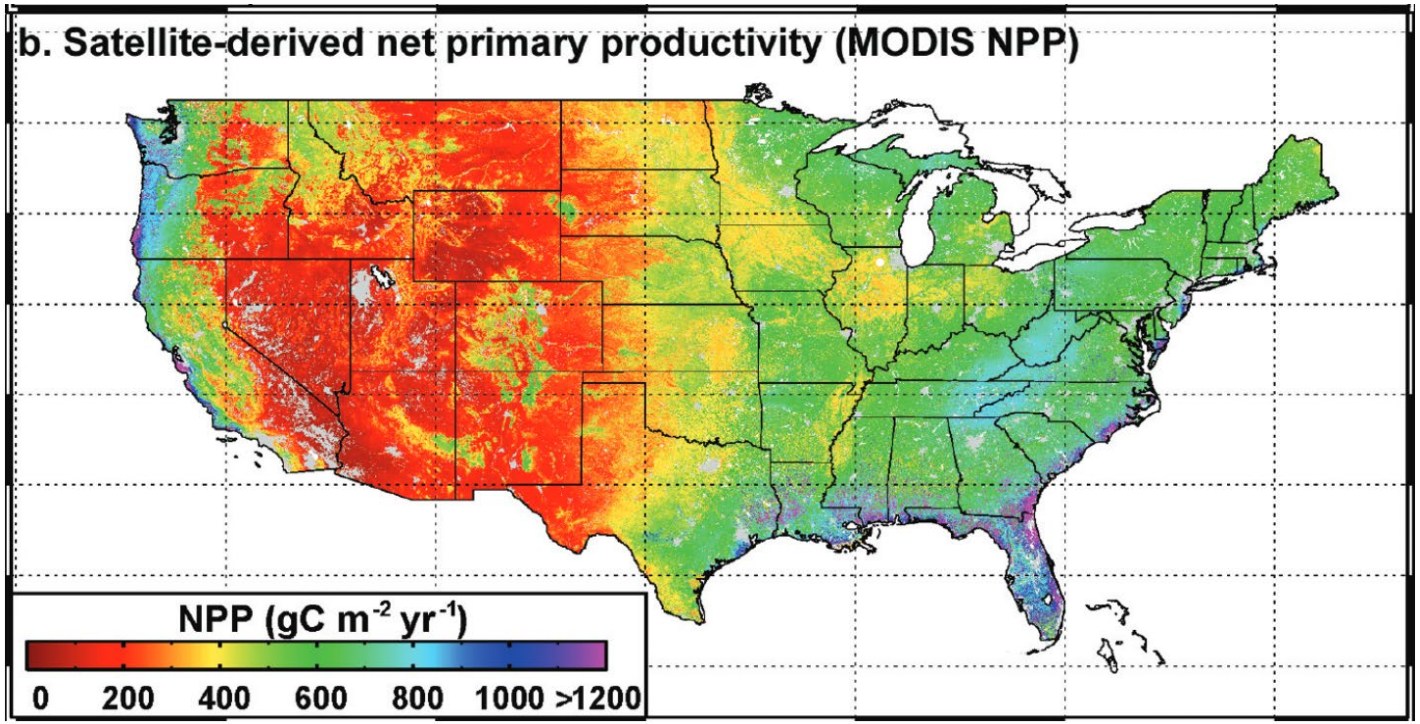
LANDSCAPE INFLUENCES ON MICROCLIMATE AND FOREST GROWTH CESSATION IN A SEMI-ARID MONTANE FOREST

Fin Malone
B.S. Ecosystem Science and Restoration

UNIVERSITY OF MONTANA

Montana Climate Office

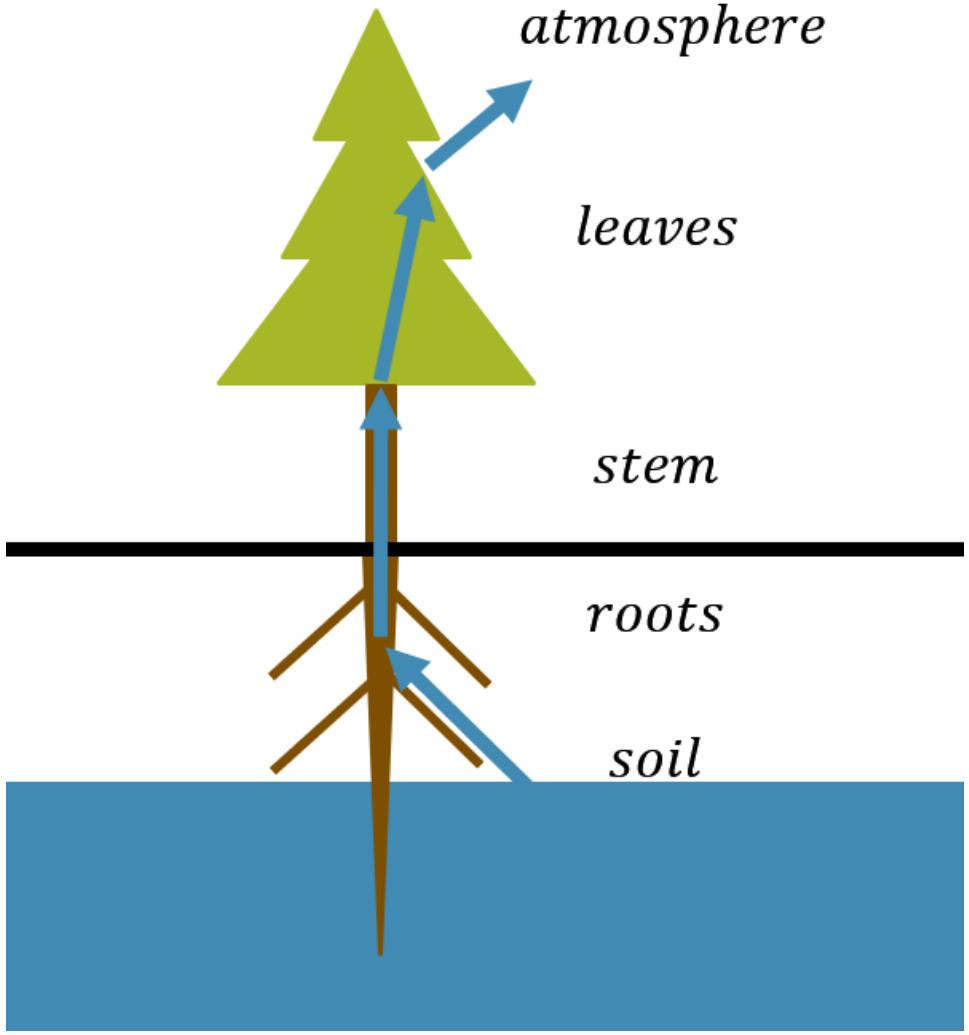
Patterns of Ecosystem Productivity



Smith et al. (2012)

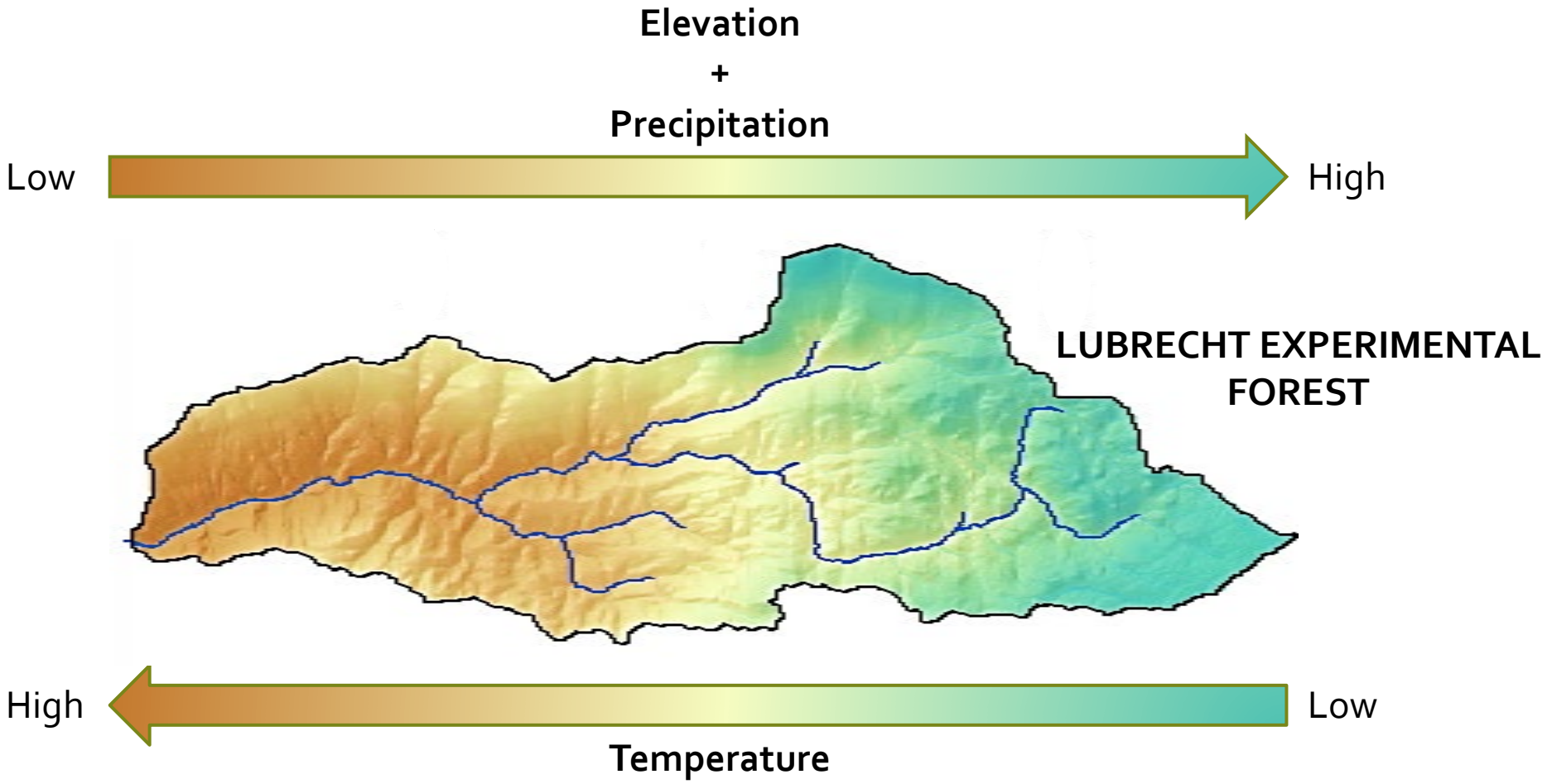
- Ecosystem productivity is driven by patterns of **water** and **energy**.
- In the western U.S., precipitation dominates this dynamic.

Tree Growth and Moisture Consumption

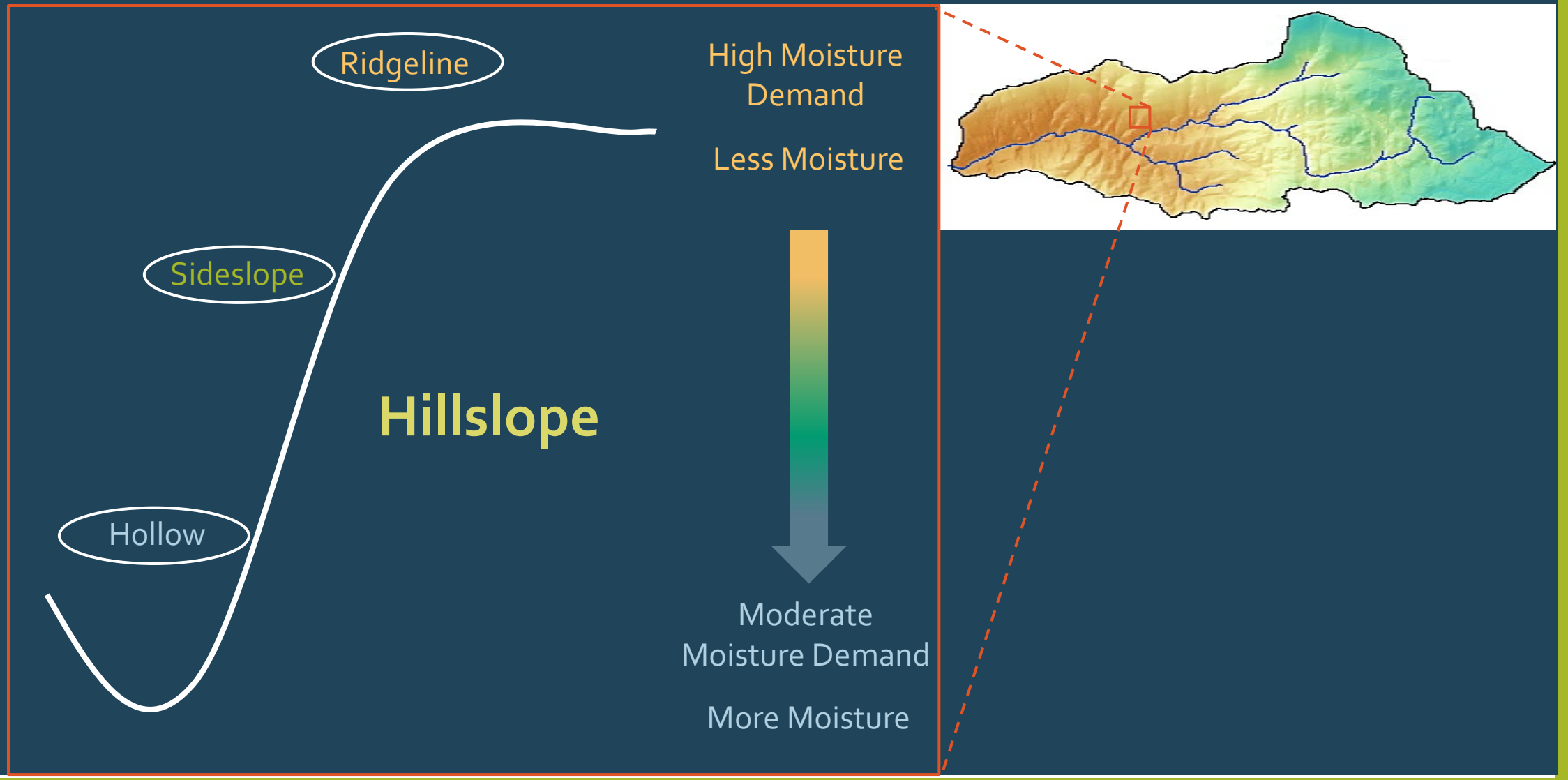


- Water is pulled through a continuum of increasing tension.
- The **atmosphere** and **soil** are measurable end-points of this continuum.
- These can be used to measure spatial differences of water availability and demand.

At the Watershed Scale



At the Hillslope Scale



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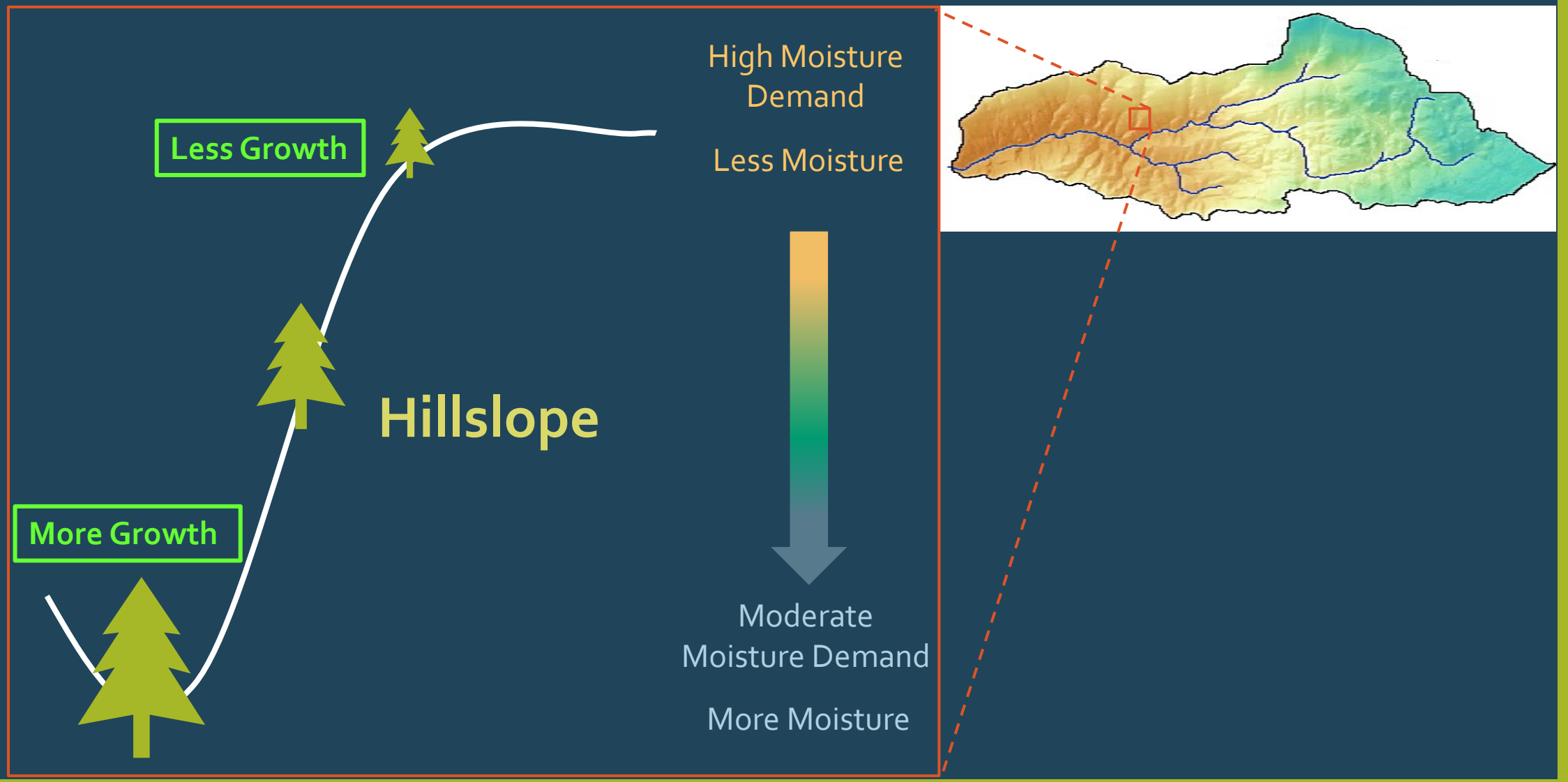
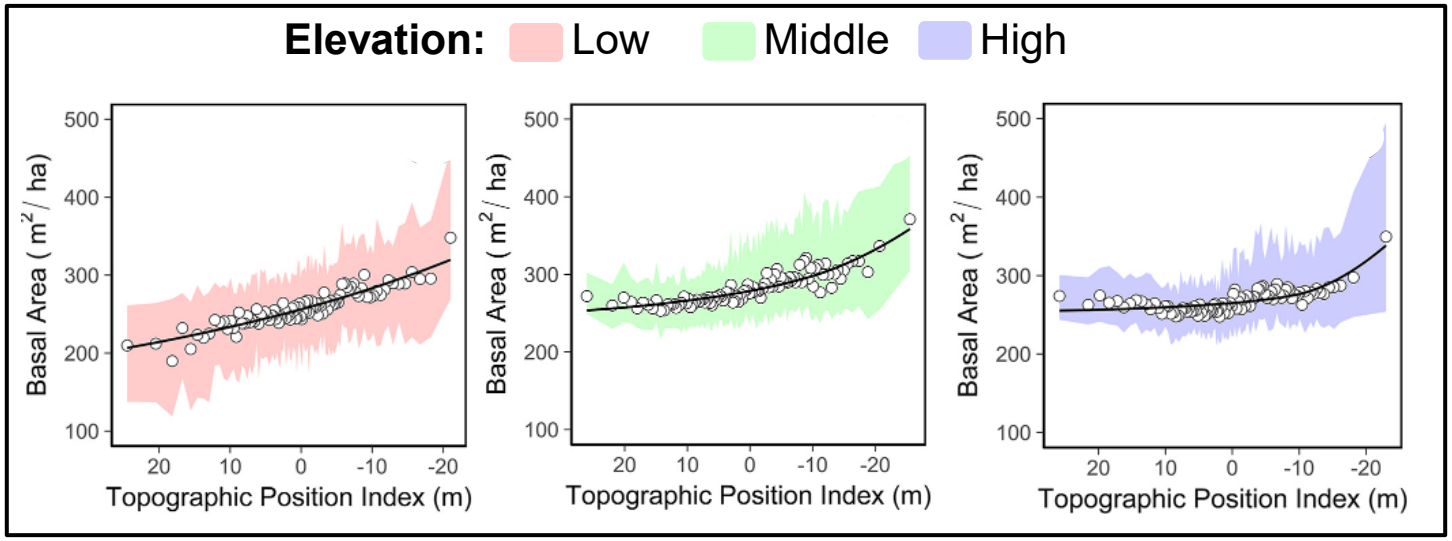


Significance

Hoylman *et al.* (2018)



- Cumulative growth patterns relate to landscape position.
- What about **seasonal trends**?

Research Questions

1. How does landscape position affect microclimate?

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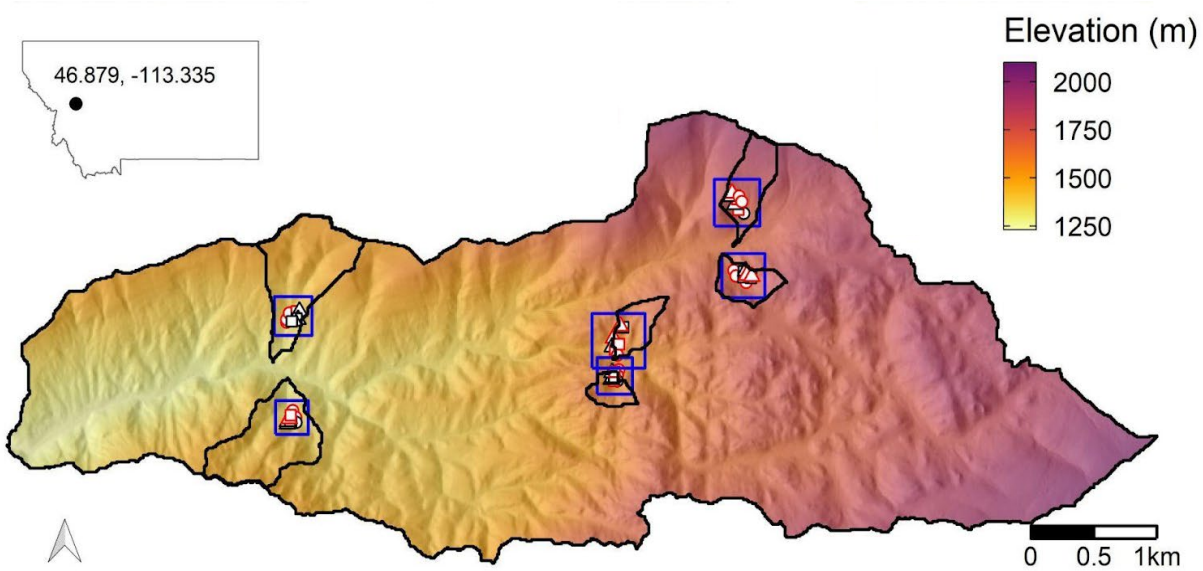
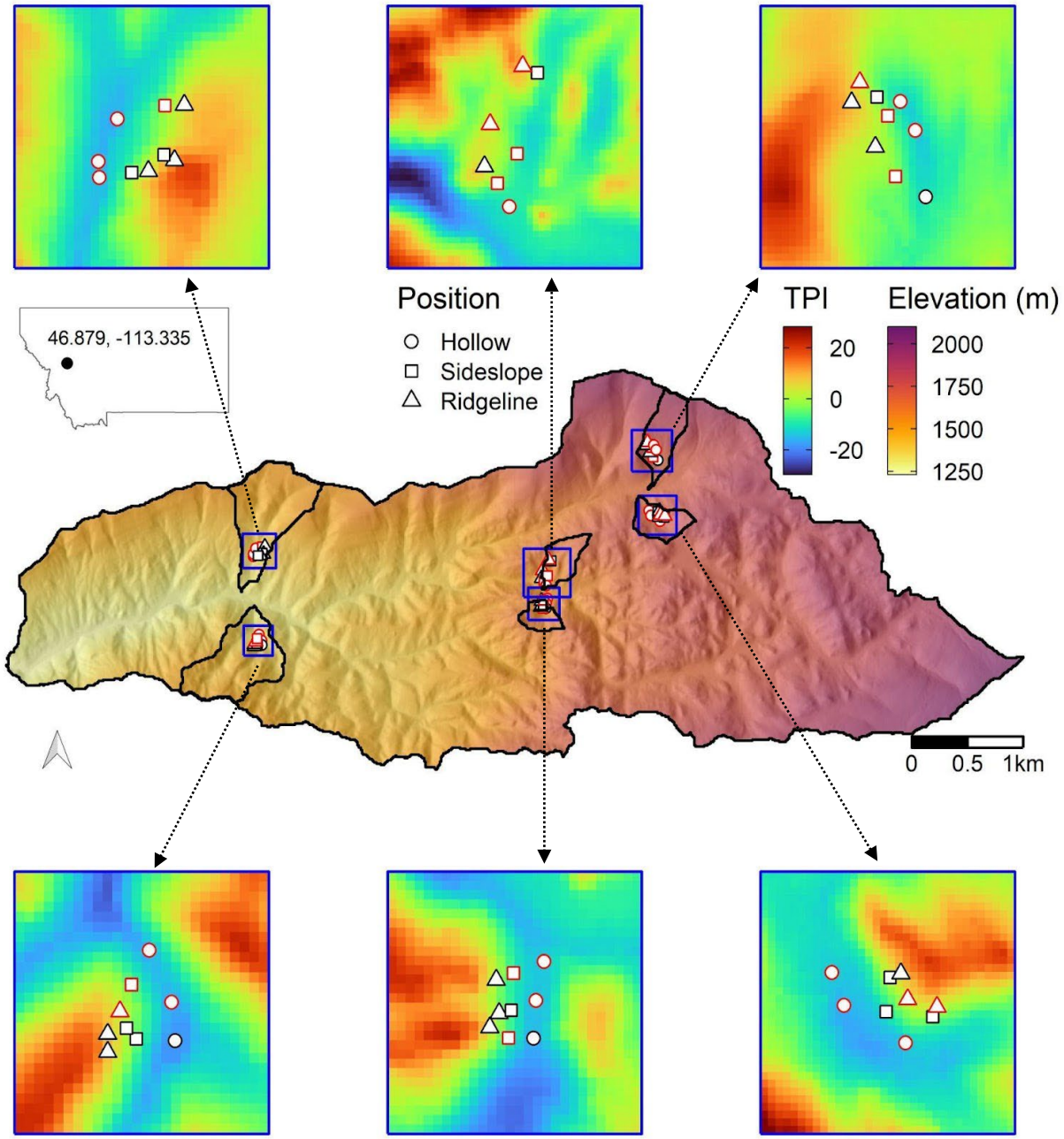
1. How does landscape position affect microclimate?

2. How does microclimate affect seasonal growth cessation?



NORTH FORK ELK CREEK CATCHMENT

Hoylman *et al.* (2019)



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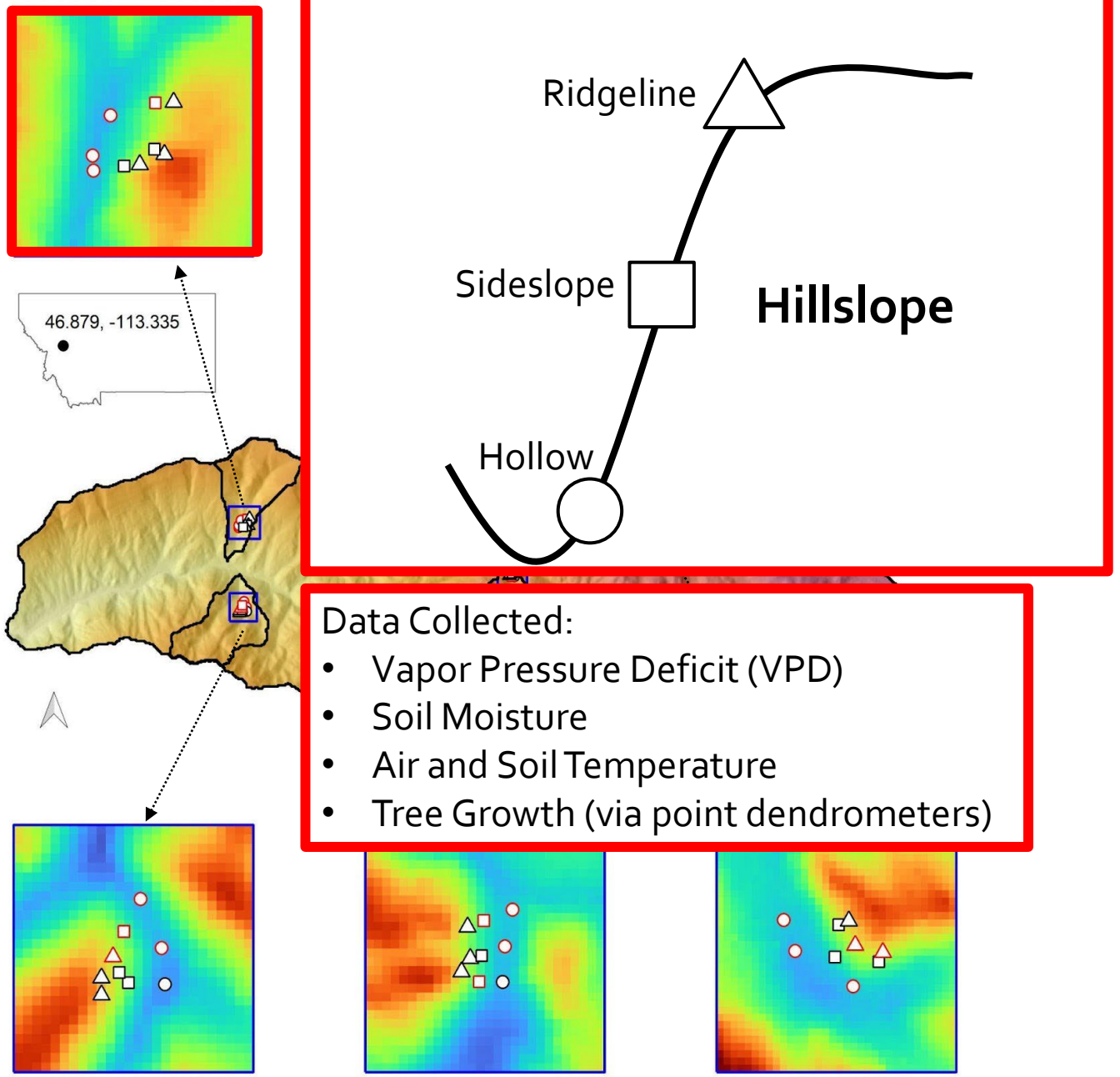


Data Collected:

- Vapor Pressure Deficit (VPD)
- Soil Moisture
- Air and Soil Temperature
- Tree Growth (via point dendrometers)

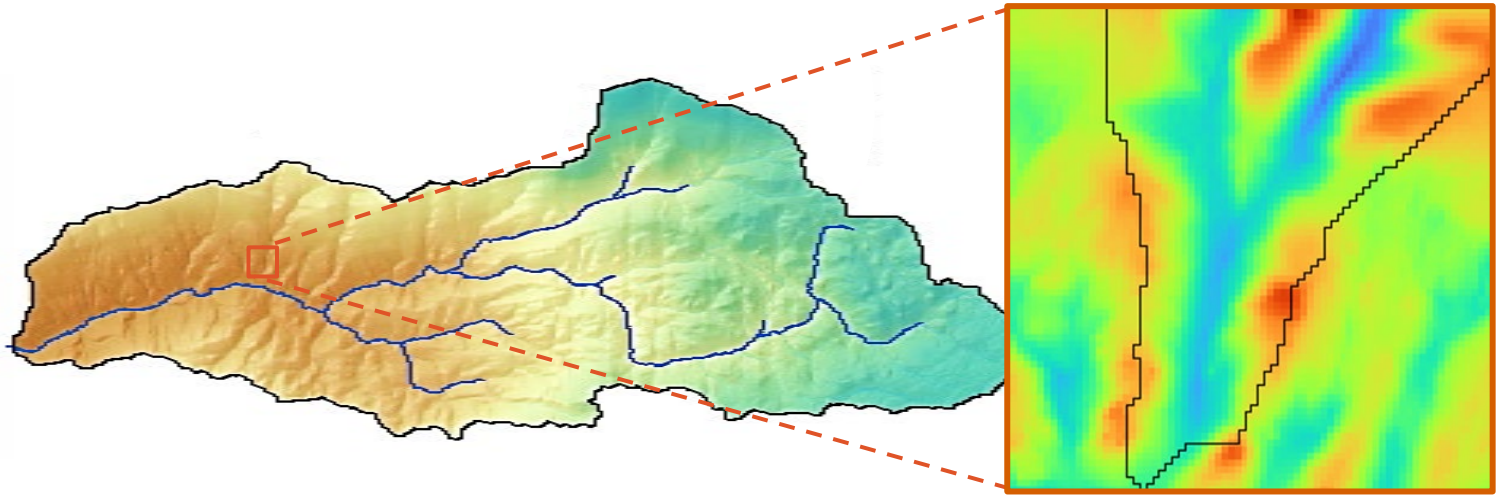
NORTH FORK ELK CREEK CATCHMENT

Hoylman *et al.* (2019)

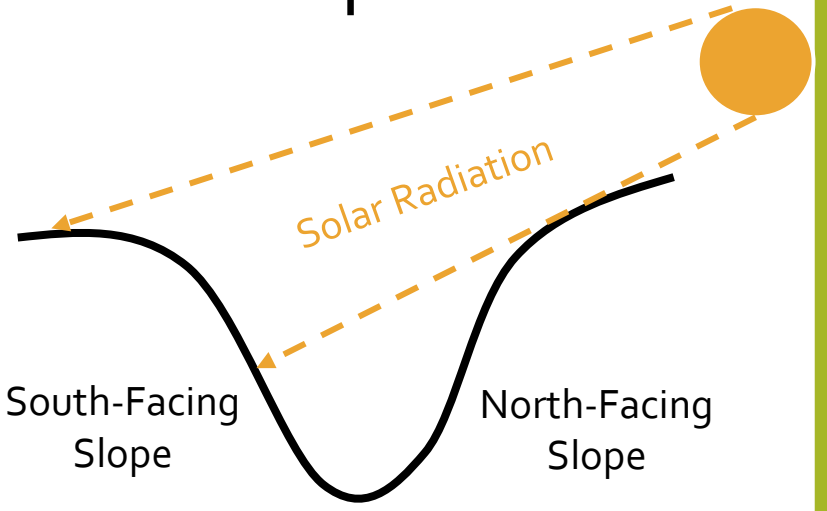
Measuring Landscape Position

Elevation

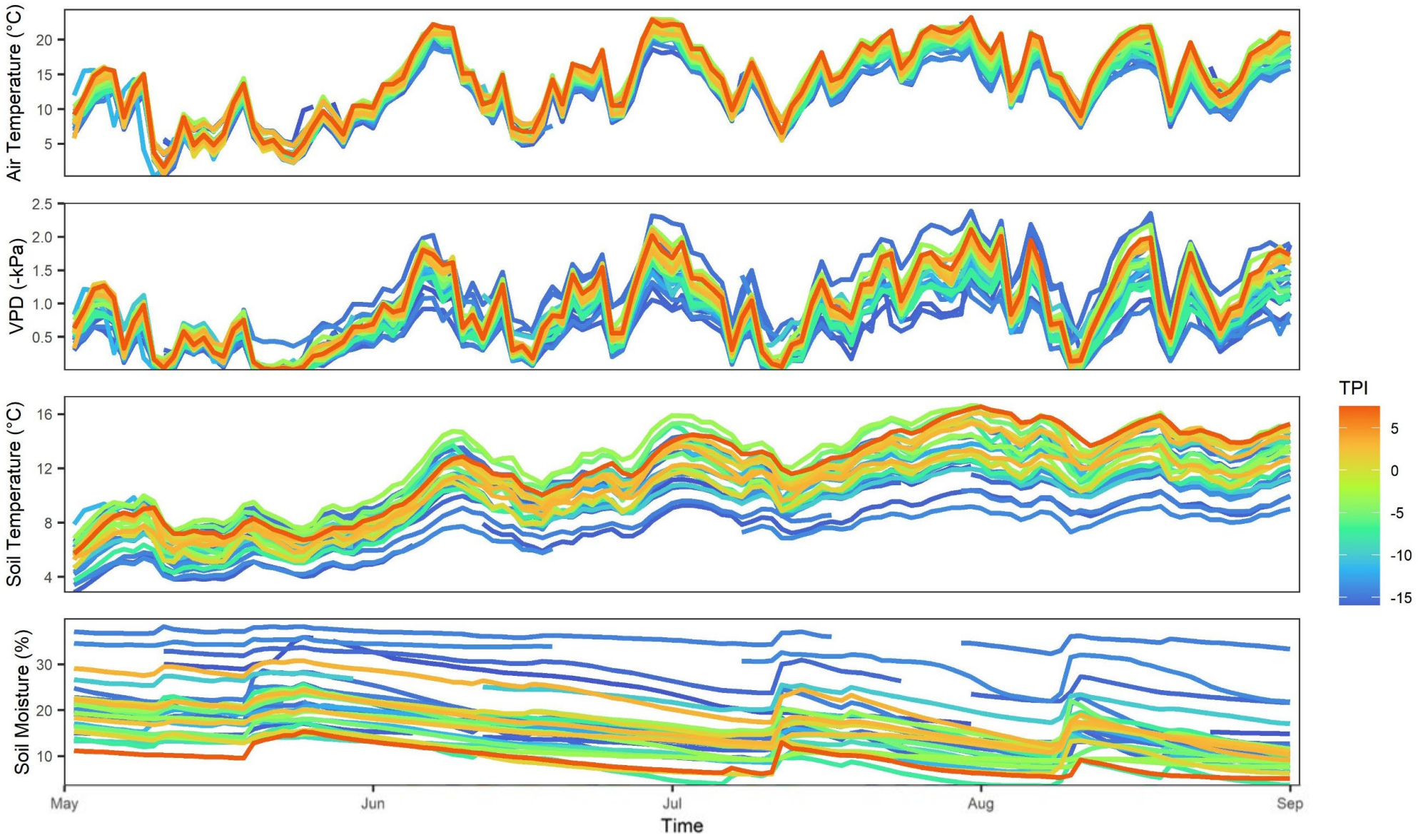
TPI



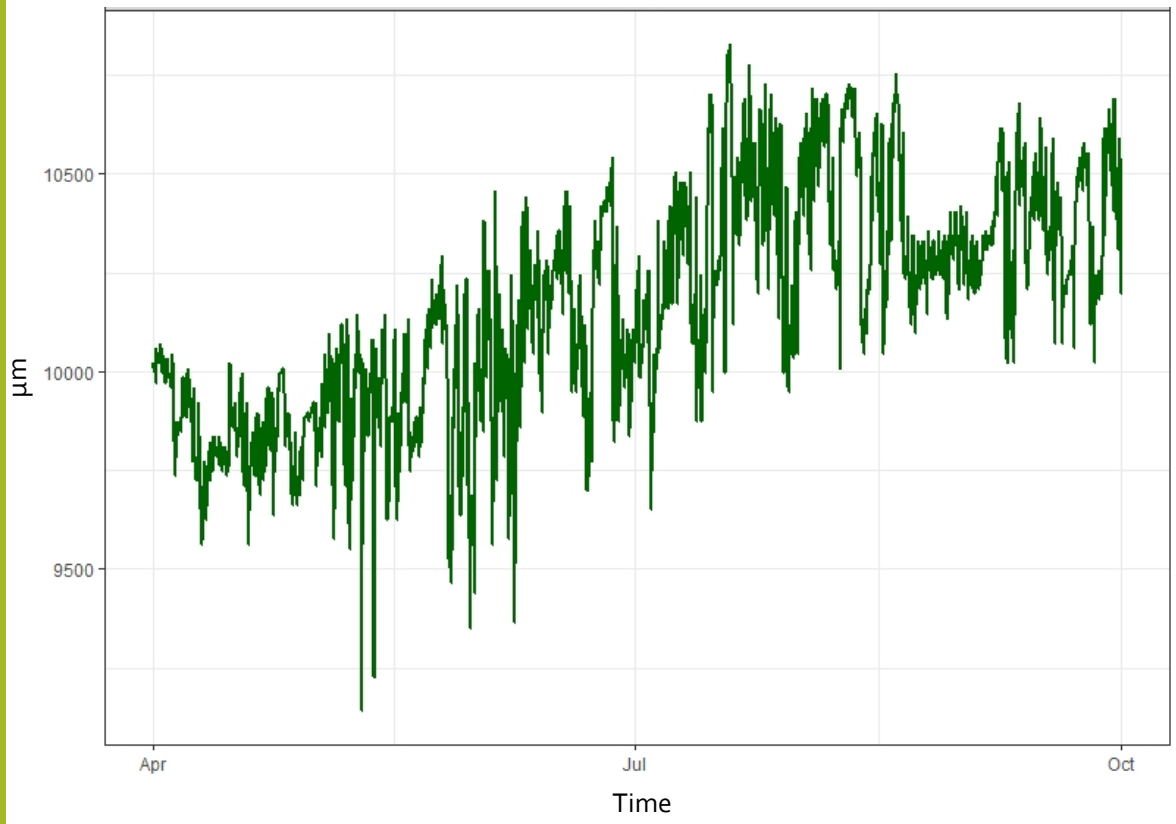
Aspect



Measuring Microclimate

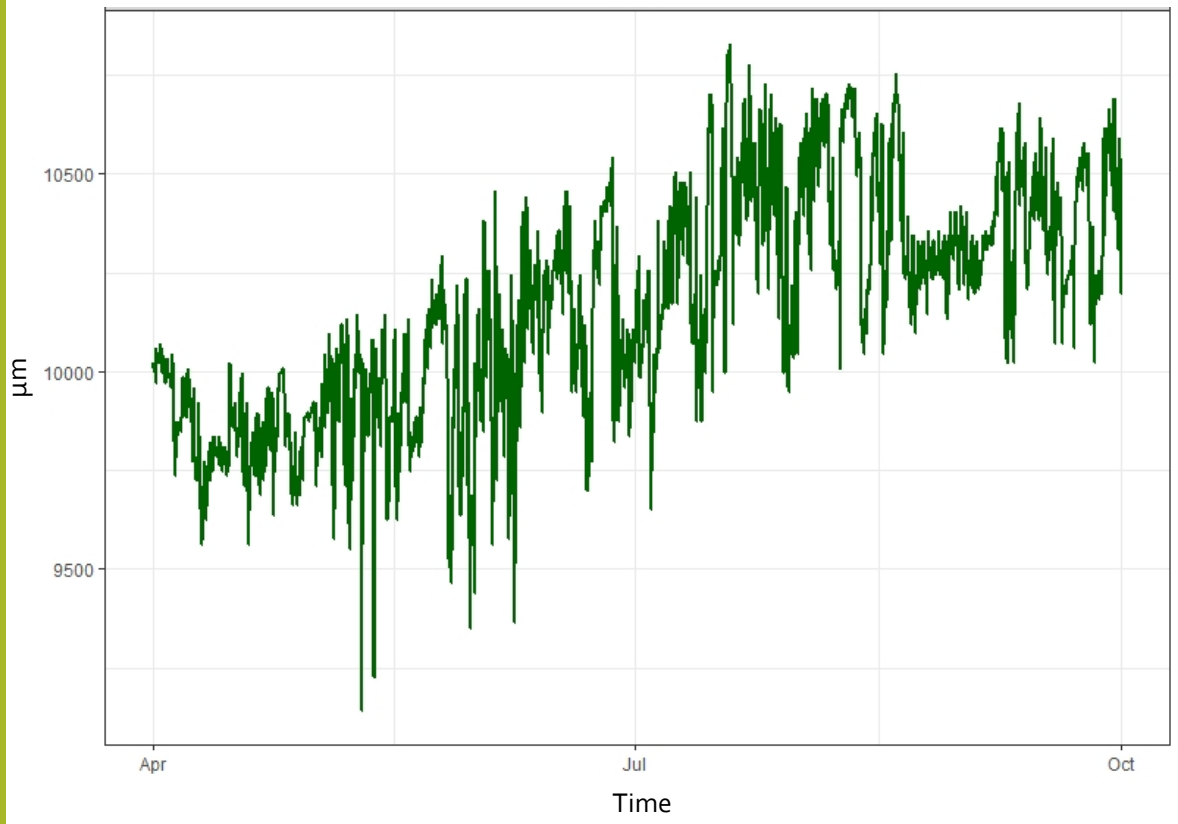


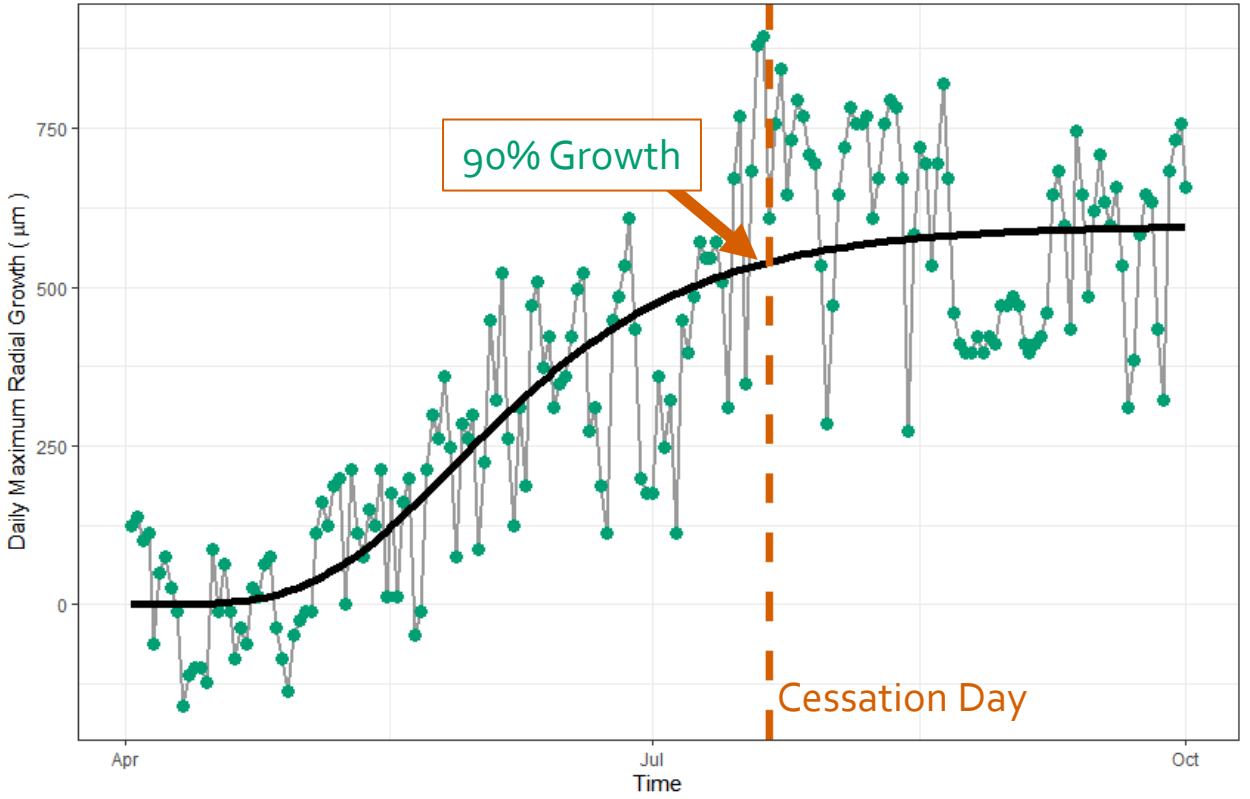
Measuring Douglas-fir Growth



Raw Data

Measuring Douglas-fir Growth





Raw Data → Gompertz Growth Curve

Results:

1. How does landscape position affect microclimate?

Microclimatic Variable	Landscape Predictors	% Variance Explained
Air Temperature	Elevation TPI Aspect	65%
Soil Temperature	Elevation TPI Aspect	49%
Vapor Pressure Deficit	Elevation TPI Aspect	38%
Soil Moisture	TPI Aspect	21%

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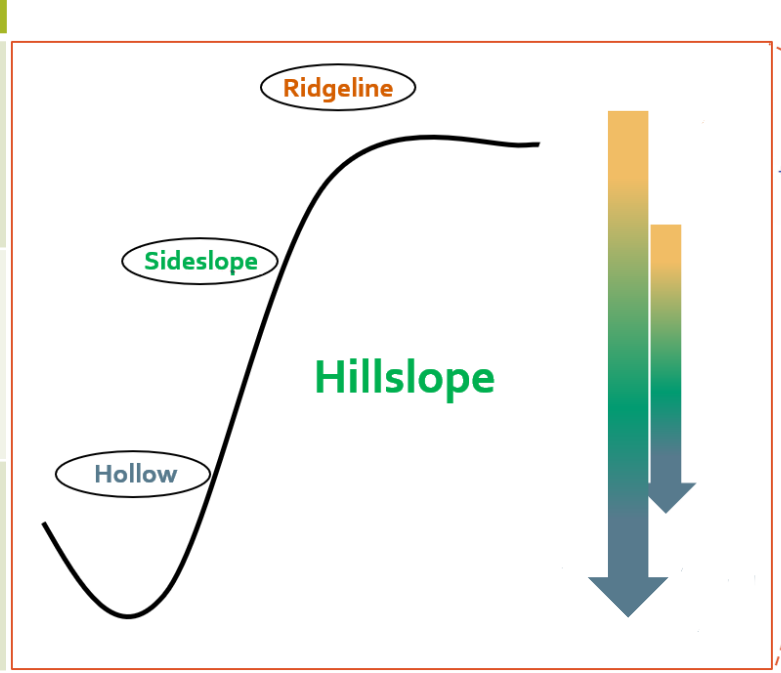
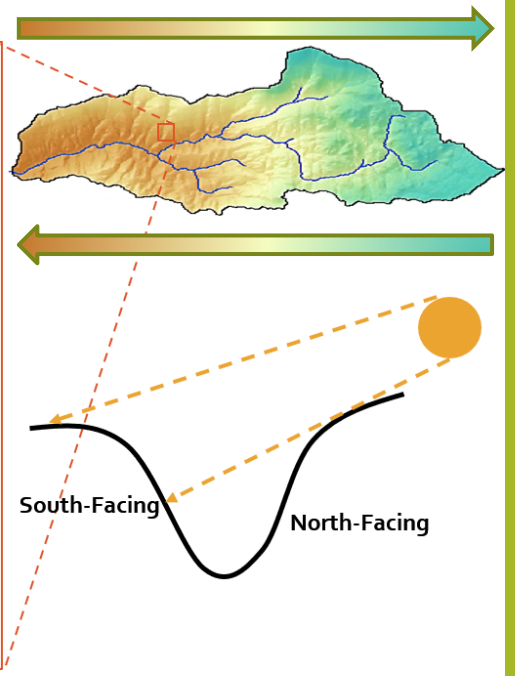
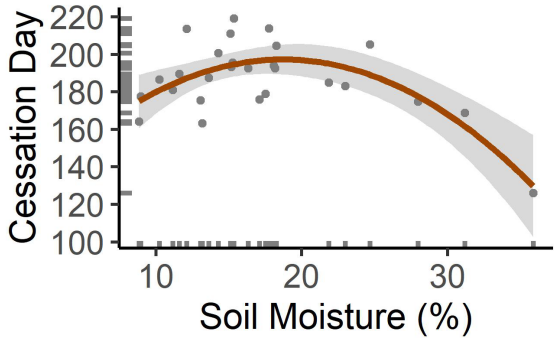
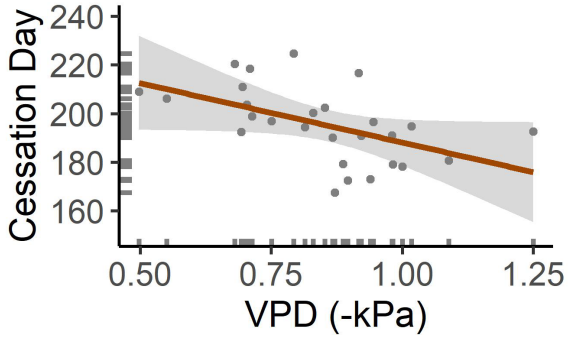


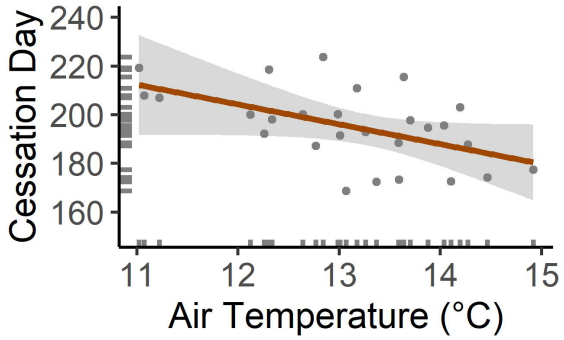


Results:

2. How does microclimate affect seasonal growth cessation?



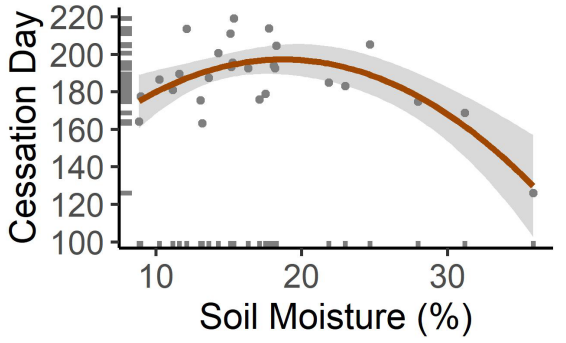


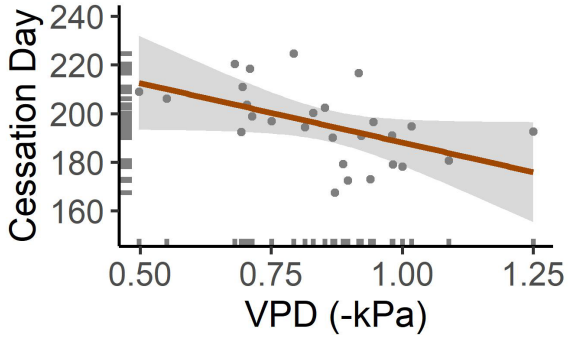


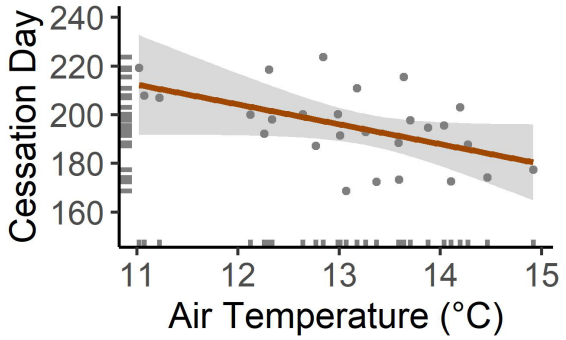
- VPD and air temperature had negative effects.
- Both extremely dry and wet soil conditions cause earlier cessation.

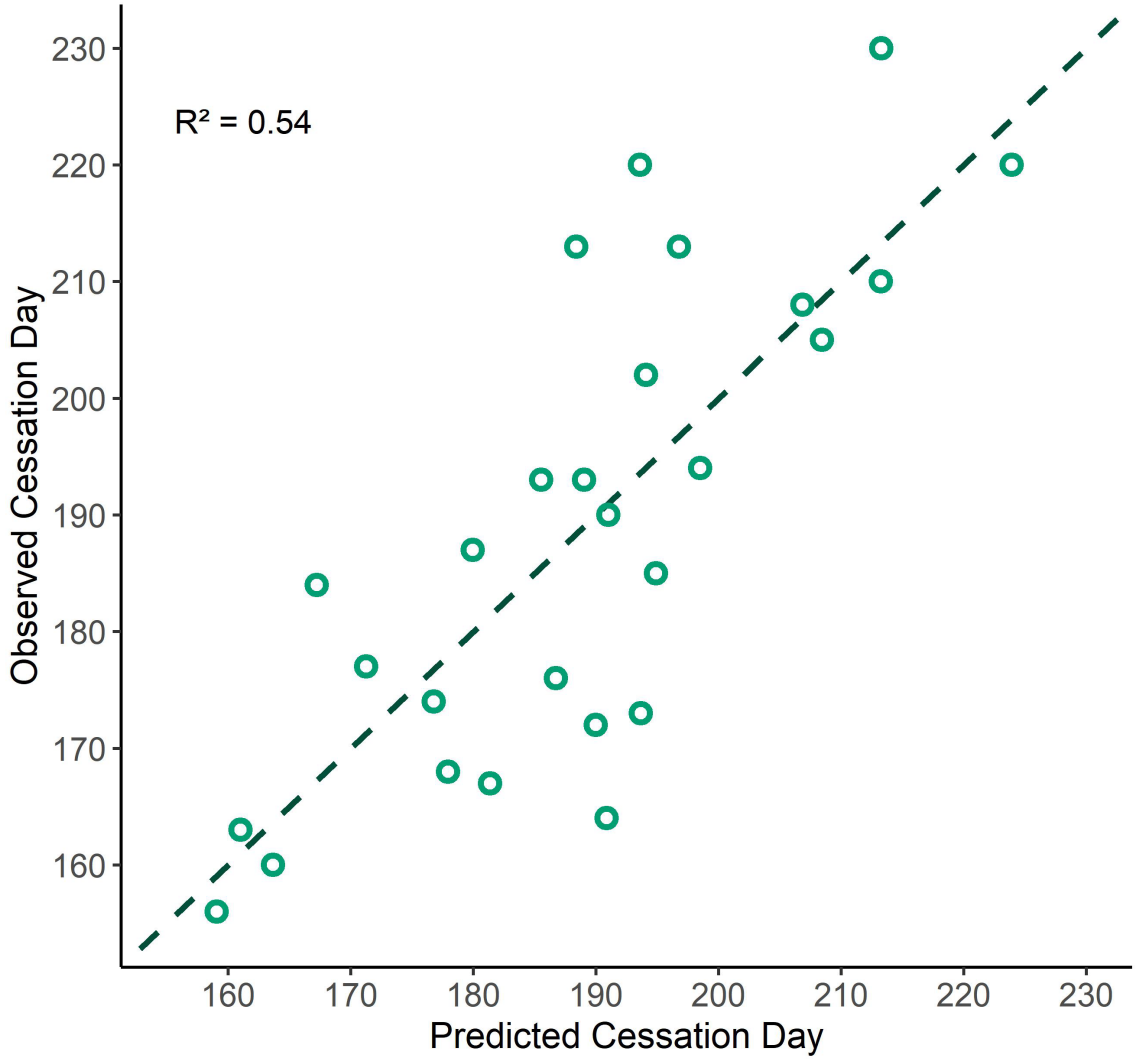
Results:

2. How does microclimate affect seasonal growth cessation?









- VPD and air temperature had negative effects.
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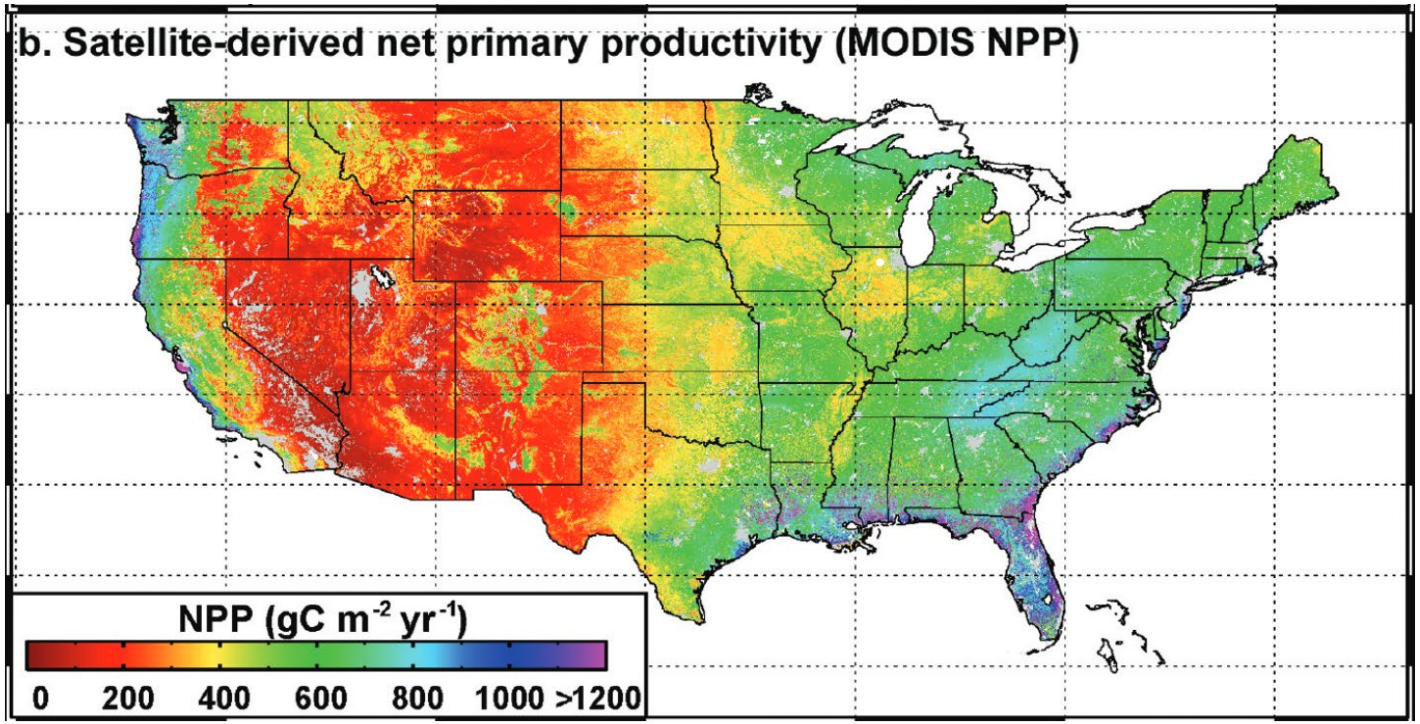
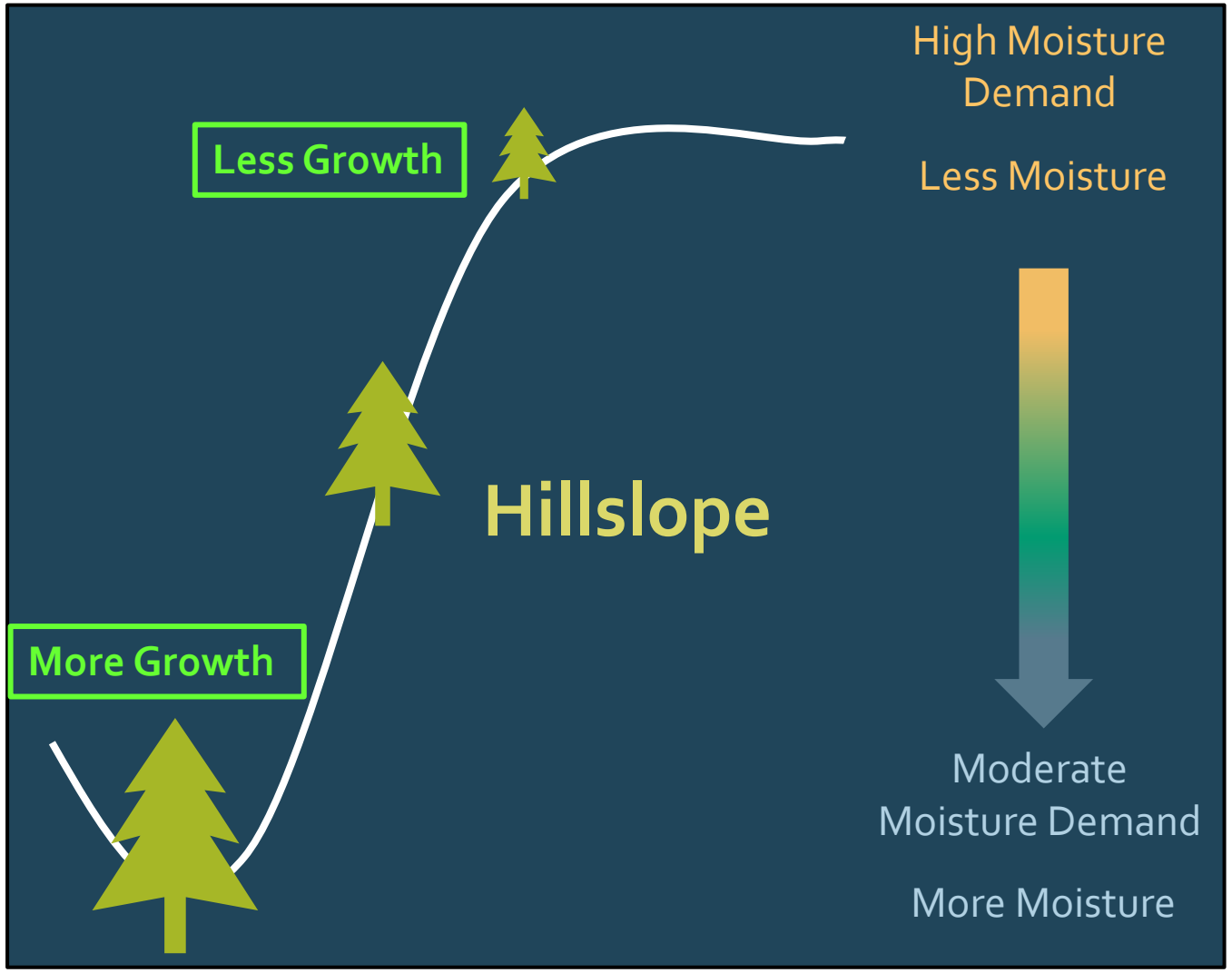
Remember…



Smith et al. (2012)

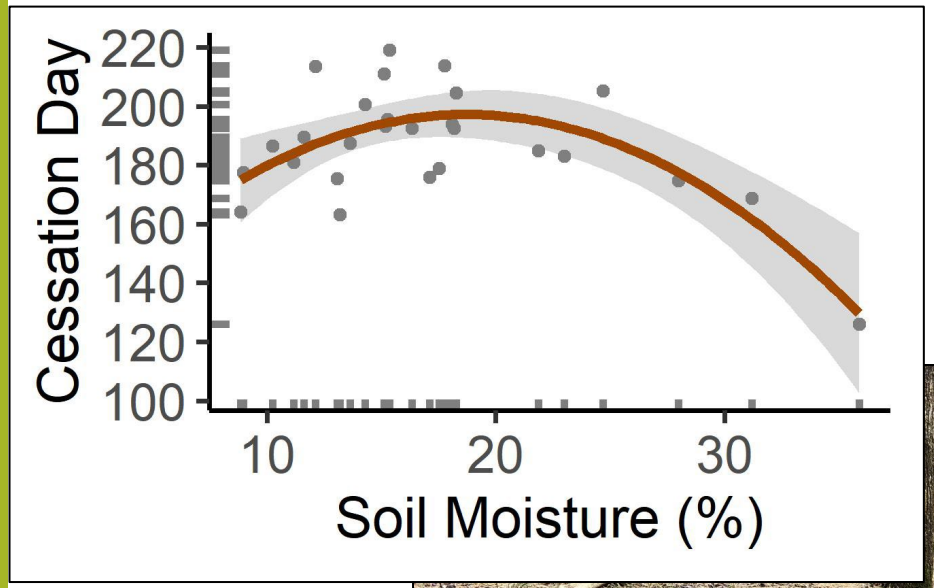
- Ecosystem productivity is driven by patterns of water and energy.
- **Small-scale patterns in the landscape follow this same rationale!**

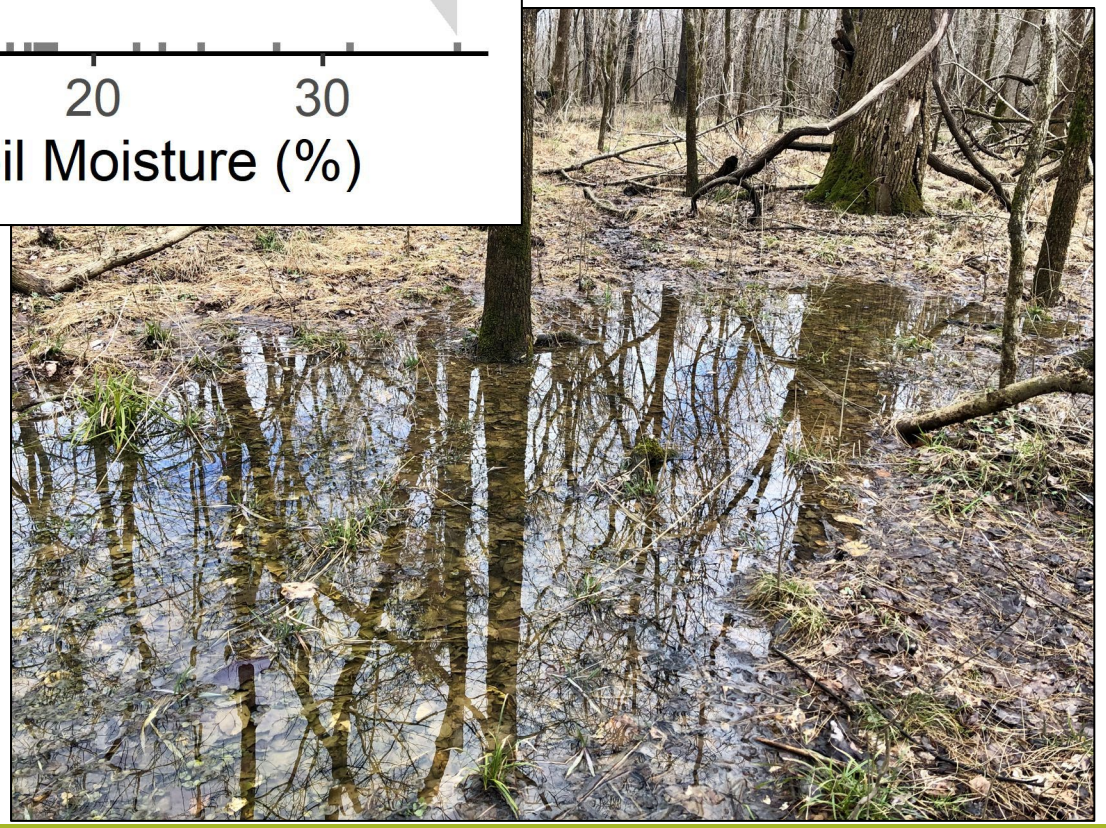
Conclusions



- **Gradients in local microclimate drive both cumulative and seasonal limitations of Douglas-fir growth.**

Conclusions





- Gradients in local microclimate drive both cumulative and seasonal limitations of Douglas-fir growth.
- **Too much soil moisture is limiting!**

Conclusions

- Gradients in local microclimate drive both cumulative and seasonal limitations of Douglas-fir growth.
- Too much soil moisture is limiting!
- **Quantifying microclimatic patterns across complex landscapes can help us predict forest growth responses under a changing climate.**

Thanks

- Advisors: Kelsey Jencso and Zachary Hoylman

- Irene Evers' Competitive Undergraduate Research Scholarship
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FIN

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