Snow-Forest Interactions Along an Elevation Gradient in the Oregon Cascades: *Implications for Forest Management*

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In the seasonal snow zone, snowmelt acts as a moisture “subsidy” for forest ecosystems, providing cooler temperatures and soil moisture during summer

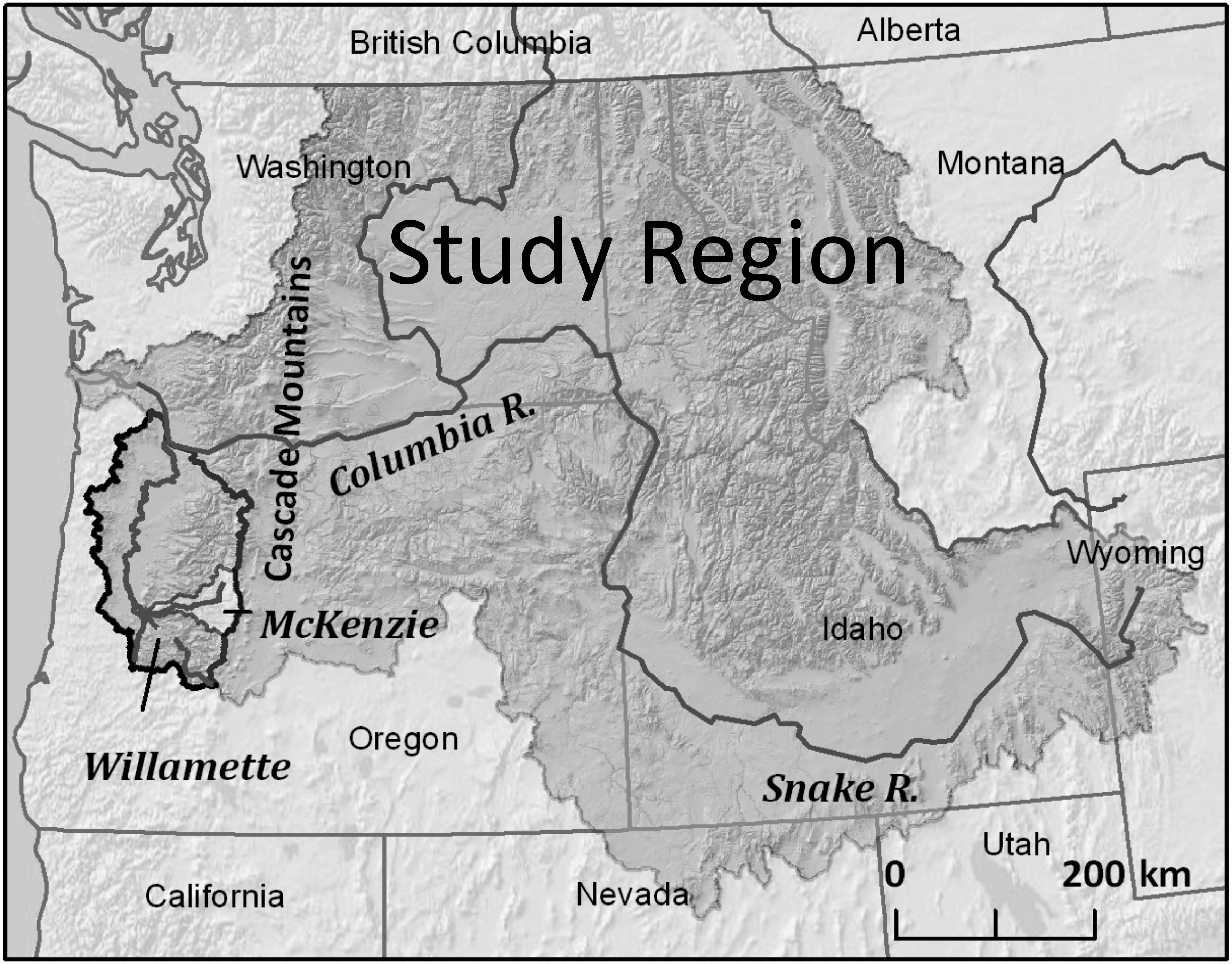
But what about the so-called “rain-snow transition zone”?

What is the role of snow in places where we also have rain?

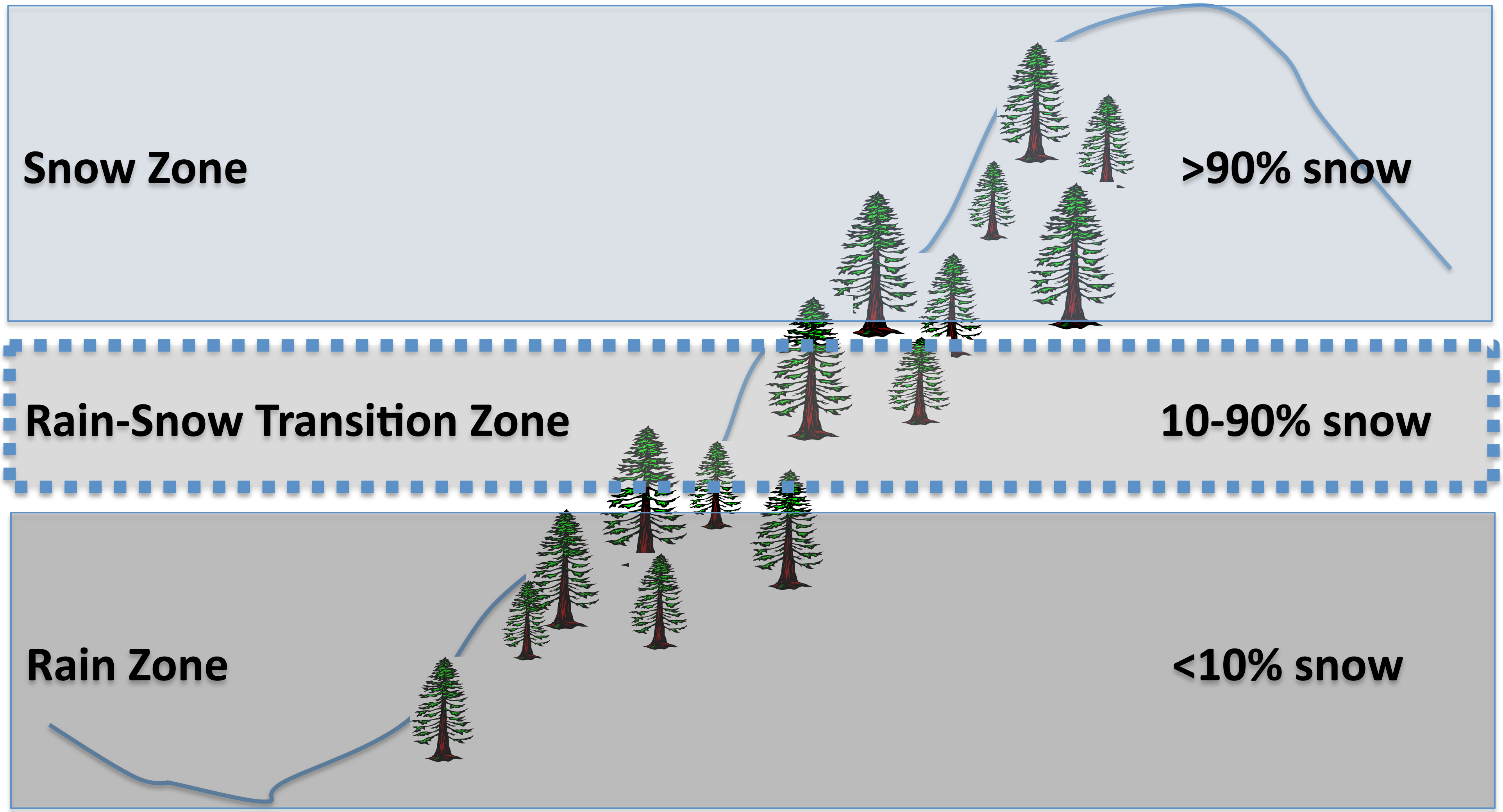
"Maritime" Snow Climate

- High precipitation, most of it occurs close to the melting point
- Rain vs. snow depends on storm temperature
- Large mid-winter melt events are not uncommon

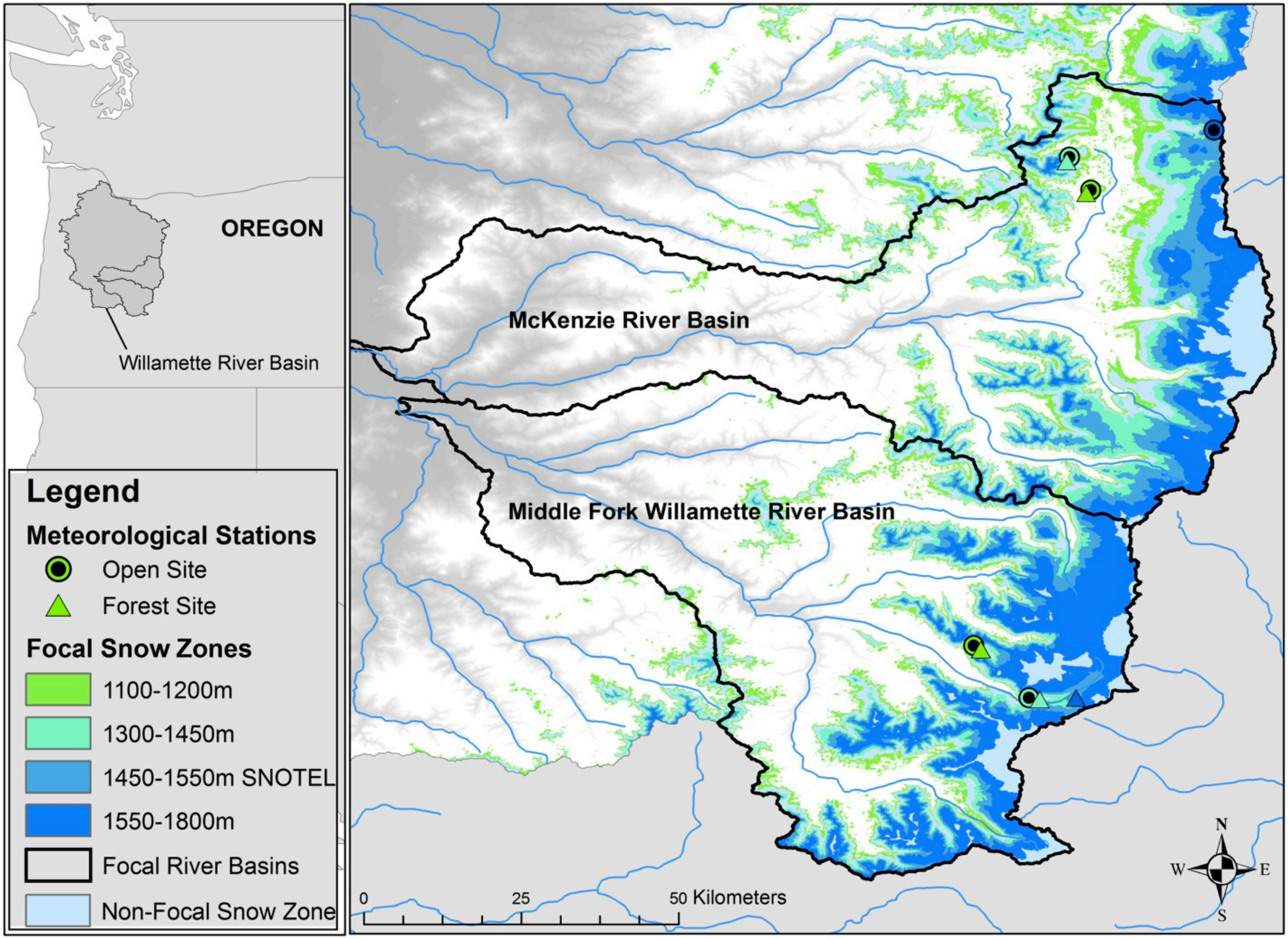
So, how do forests influence patterns of snow accumulation and melt? How does that vary by elevation?


British Columbia
Alberta
Washington
Montana
Study Region
Cascade Mountains
Columbia R.
Wyoming
McKenzie
Idaho
Oregon
Willamette
Snake R.
Utah
0
200 km
California
Nevada

Winter Precipitation Zones



Willamette Water 2100 Meteorological Stations



Pacific Northwest Temperate Coniferous Forest

Snow and Meteorological Measurements

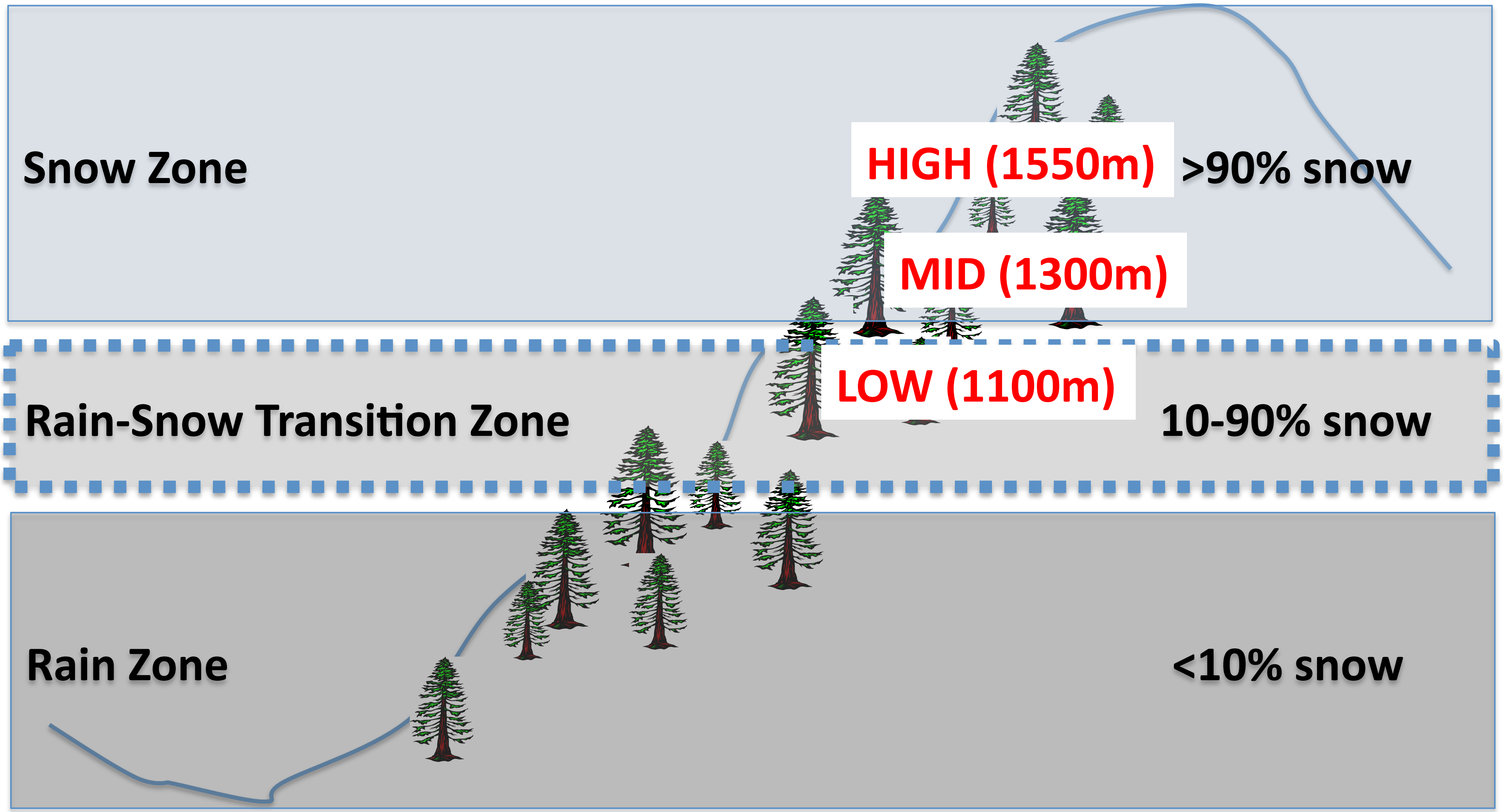
Monthly/Bimonthly Snow Surveys

Meteorological and Snow Monitoring

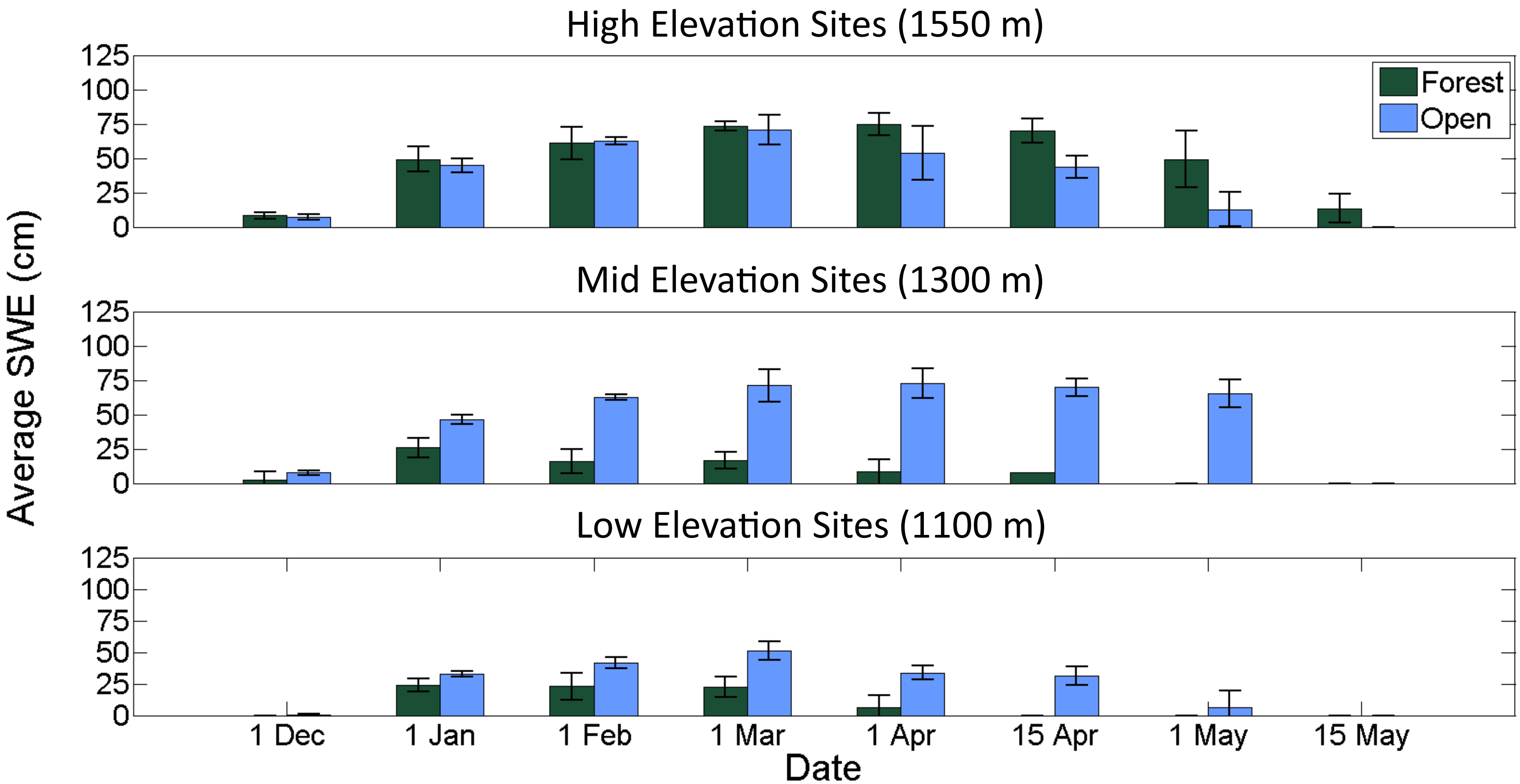
Results: Snow retention depends on:

1. How much snow accumulates during winter
2. How fast it melts

But these two processes differ for forested vs. open sites
<u>and</u> differ by elevation



Snow Zone
HIGH (1550m)
>90% snow
MID (1300m)
Rain-Snow Transition Zone
LOW (1100m)
10-90% snow
Rain Zone
<10% snow



At high elevations, snow lasts longer in the forest

At mid- and low elevations, snow lasts longer in open areas

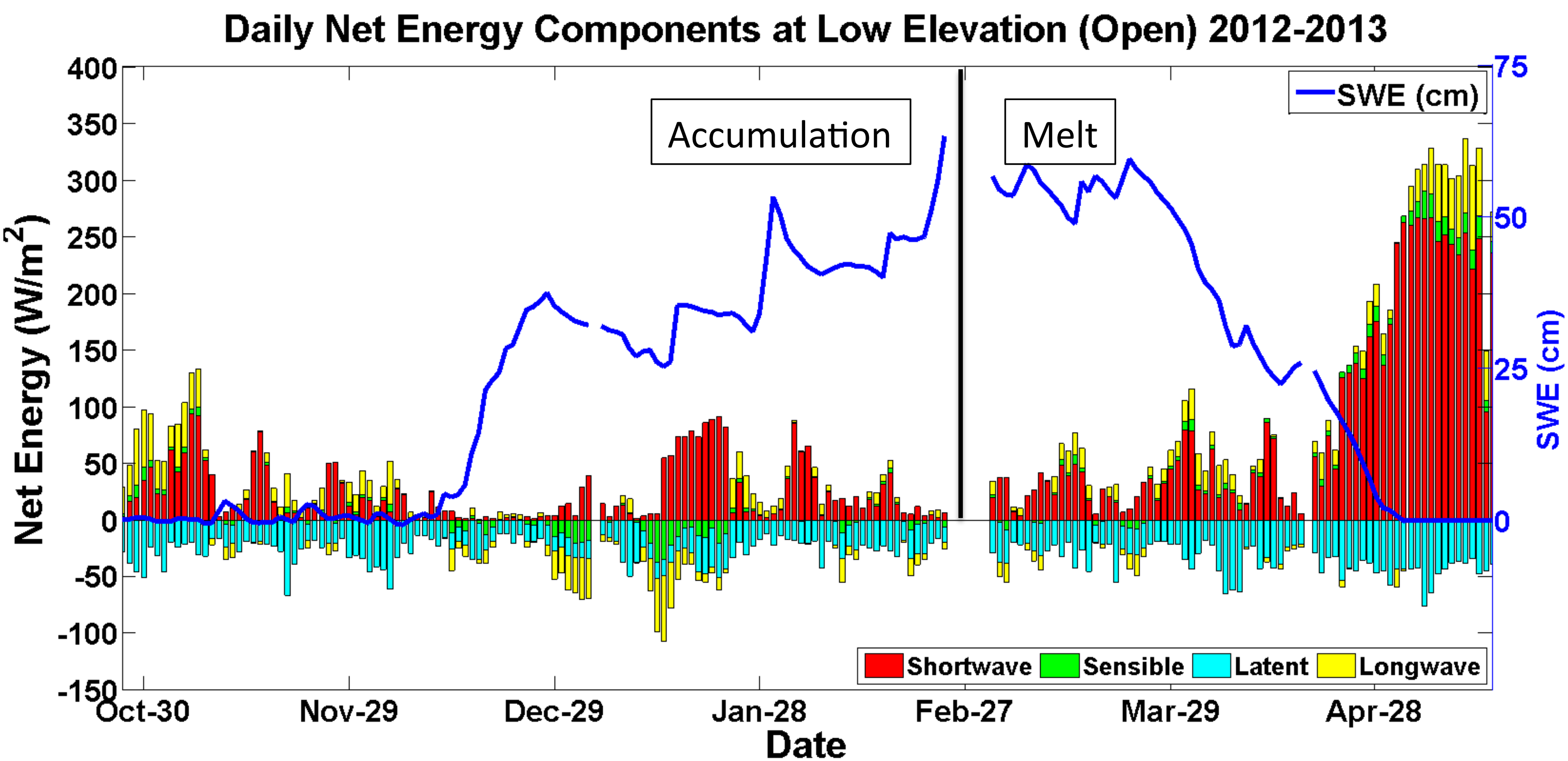
Canopy interception and SWE/Precipitation

Site	Interception	Canopy Closure	SWE/Pre
Low Elevation	68.5%	90%	0.35
Mid Elevation	46.2%	92%	0.65
High Elevation	35.6%	79%	0.95

For individual storms, medium snowfall events (<30 cm) showed large interception (>80%) while large snowfall events (>100 cm) showed interception of about 40%

Coniferous trees can only hold about 10-25 cm of SWE and beyond that amount, it is released onto the forest floor, accumulating on the sub-canopy snowpack

In open areas, solar energy makes a significant contribution to energy available for snowmelt

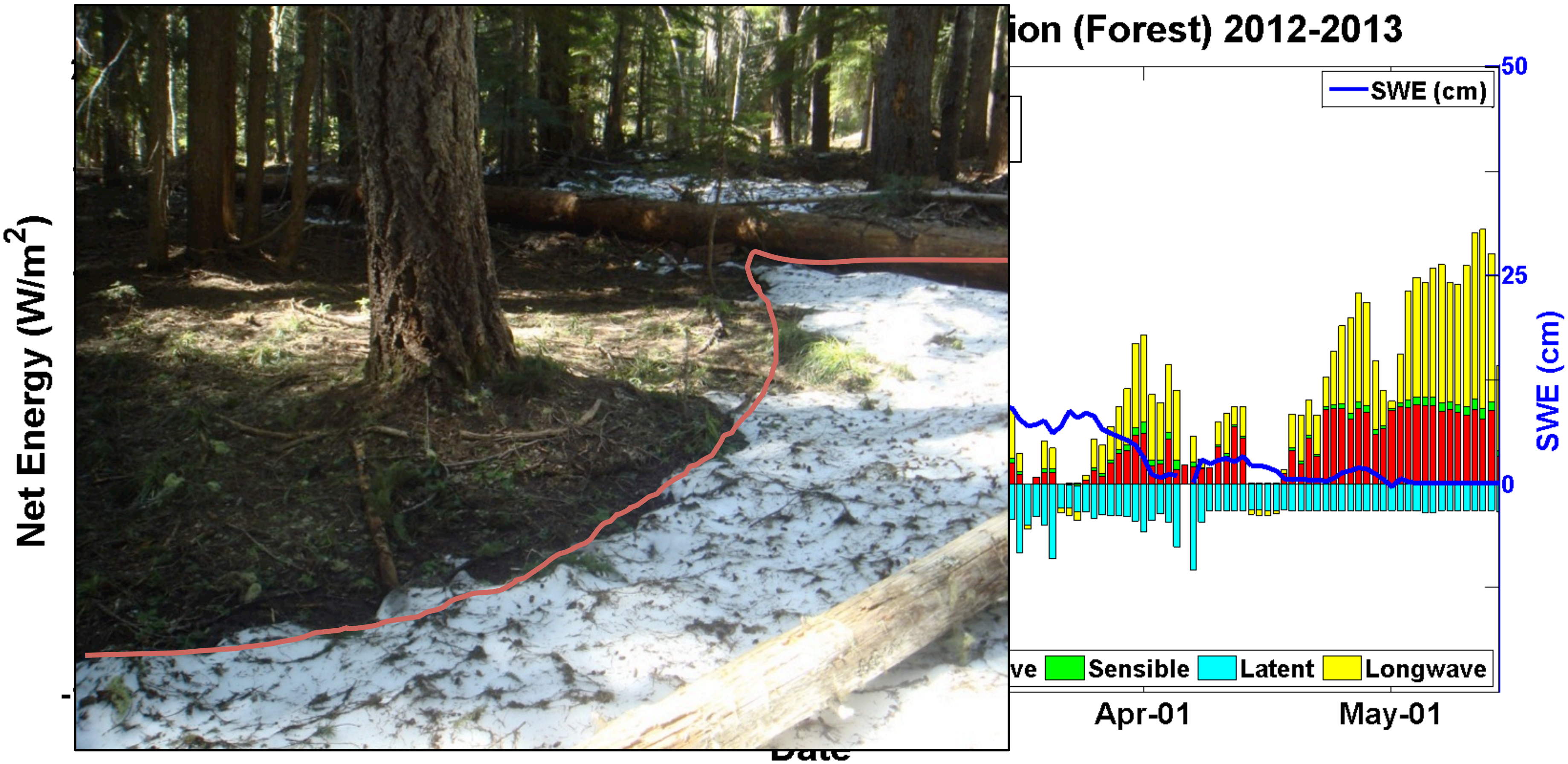


Sky View Fraction = 0.69

Mean tree height = 8.9 m

Mean crown radius = 1.9 m

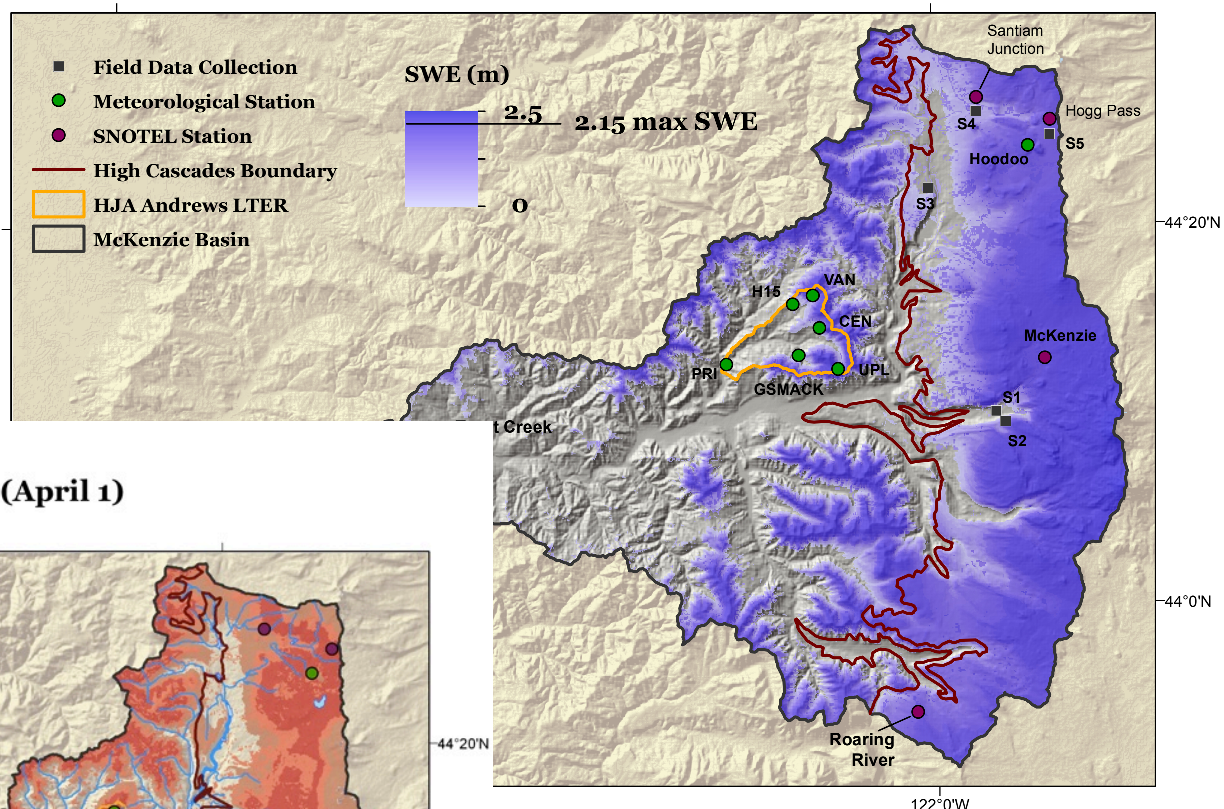
In the forest, thermal energy makes a significant contribution to energy available for snowmelt



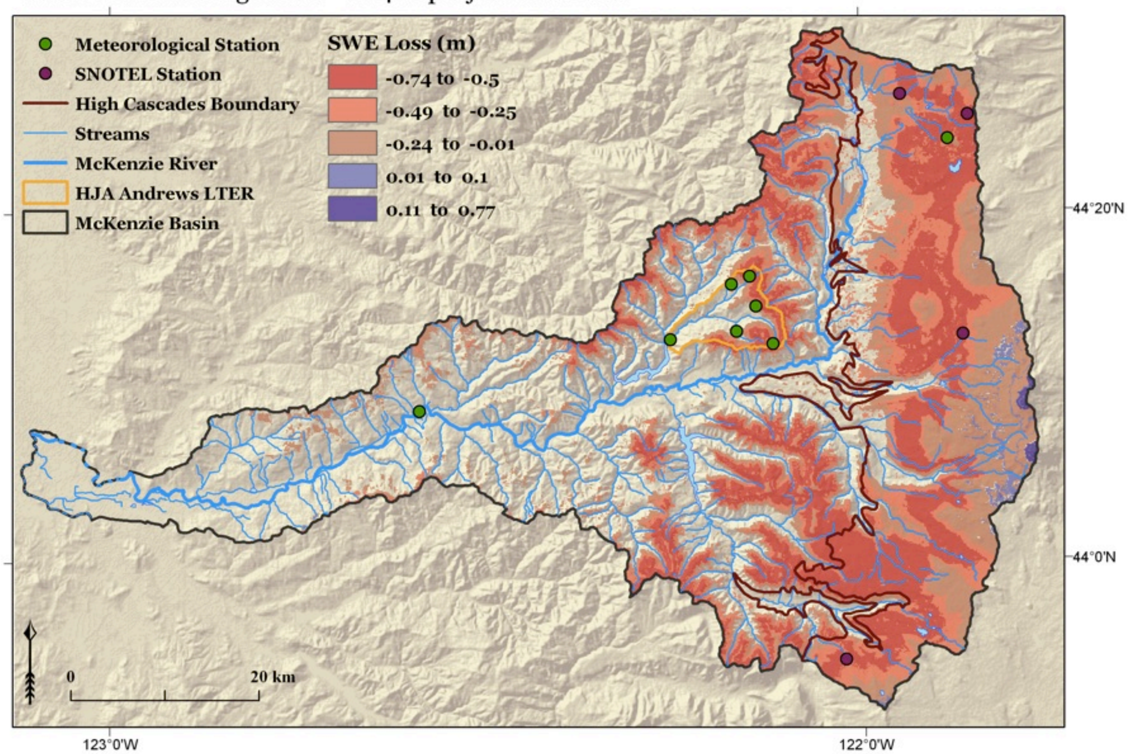
Sky View Fraction = 0.11
Mean tree height = 33.7 m
Mean crown radius = 4.7 m

We need to include the effects of forest structure in our snow hydrology models

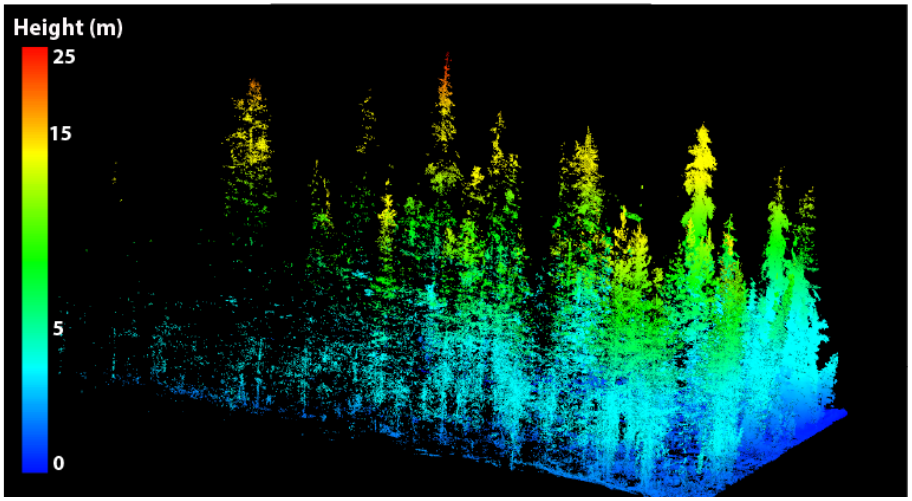
Snow Water Equivalence
April 1, 2009

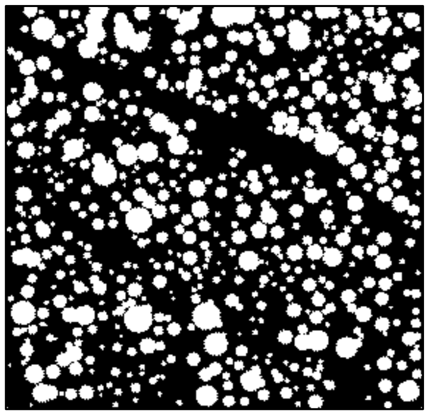


Modeled Loss of Snow Water Equivalent (April 1)
Winter with Average SWE - 2040s projected climate



Modeled changes in SWE for the McKenzie River Basin. Sproles et al. 2013





We also need to map and characterize forest structure at appropriate spatial resolutions

Combining models and measurements, we need to assess the effects of forest density on snowpack retention, for different elevations, now and into the future

Summary

- Forest structure matters (canopy interception, solar and thermal energy)
- Temperature matters (rain vs. snow)
- Forest gaps are important for snow retention, esp. in the lower snow zone and rain-snow transition – but what size gap??``

Food for thought:

In a warming climate, the rain-snow transition zone will shift upward. Higher elevation forests will lose snow earlier, costing them their moisture "subsidy"

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