Department of LAND, AIR AND WATER RESOURCES
University of California, Davis
Climate Change • Sustainable Agriculture
Environmental Quality • Landscape Processes

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Effects of Vertical Canopy Structure on Snow Processes

Simulation of Surface Energy Fluxes & Snow Interception Using a Higher Order Closure Multi-Layer Soil-Vegetation-Atmospheric Model

Snow cover is a critical driver of energy and water budget yet lack accurate modeling

- Forested Sierra Nevadas supply ›50% of California's water[1]
  - Natural reservoir
  - California grows › 50% of US fruits & vegetables
- Yet accurate estimates of snow cover and snowmelt in forested areas remains a challenge

1. State Of Sierra Forests Report Web

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Vertical structure & its variation complicate snow processes and modeling

- Controls snow's spatiotemporal distribution
- Alters energy & water budget
- Resolving vertical canopy structure critical to understanding snow dynamics!
- However few studies explicitly model complex processes in multiple vertical layers!

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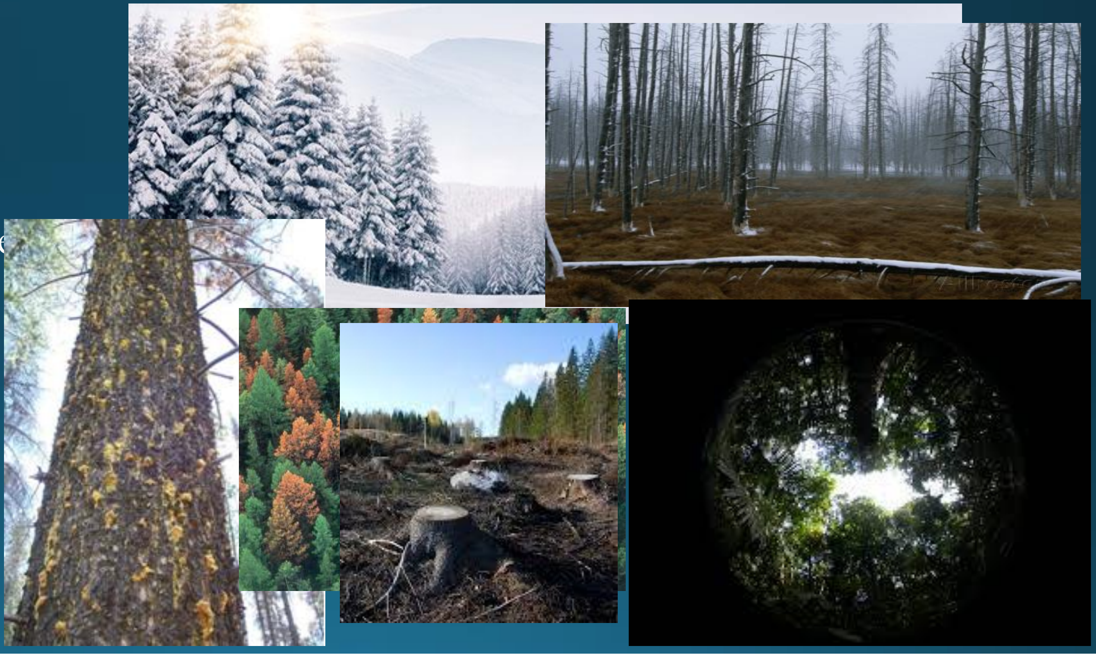
Most studies of forest structure impact on snow processes only look at planar variables

Methods to snow canopy processes

- Unperturbed forest versus
  - Open area or lake[1]
  - Clear cut forests[2]
  - Mountain pine beetles damaged fore
  - Post wildfires forest[4]
- Varied tree types[5]
- Variation in canopy parameters
  - Leaf area indices[6]
  - Canopy closure[7]
  - LIDAR structure[8]



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Objective:

Simulate differing forest canopy structures' impact on energy & snow budgets

in Sierra Nevada, CA
using a multilayer soil-canopy-atmosphere model

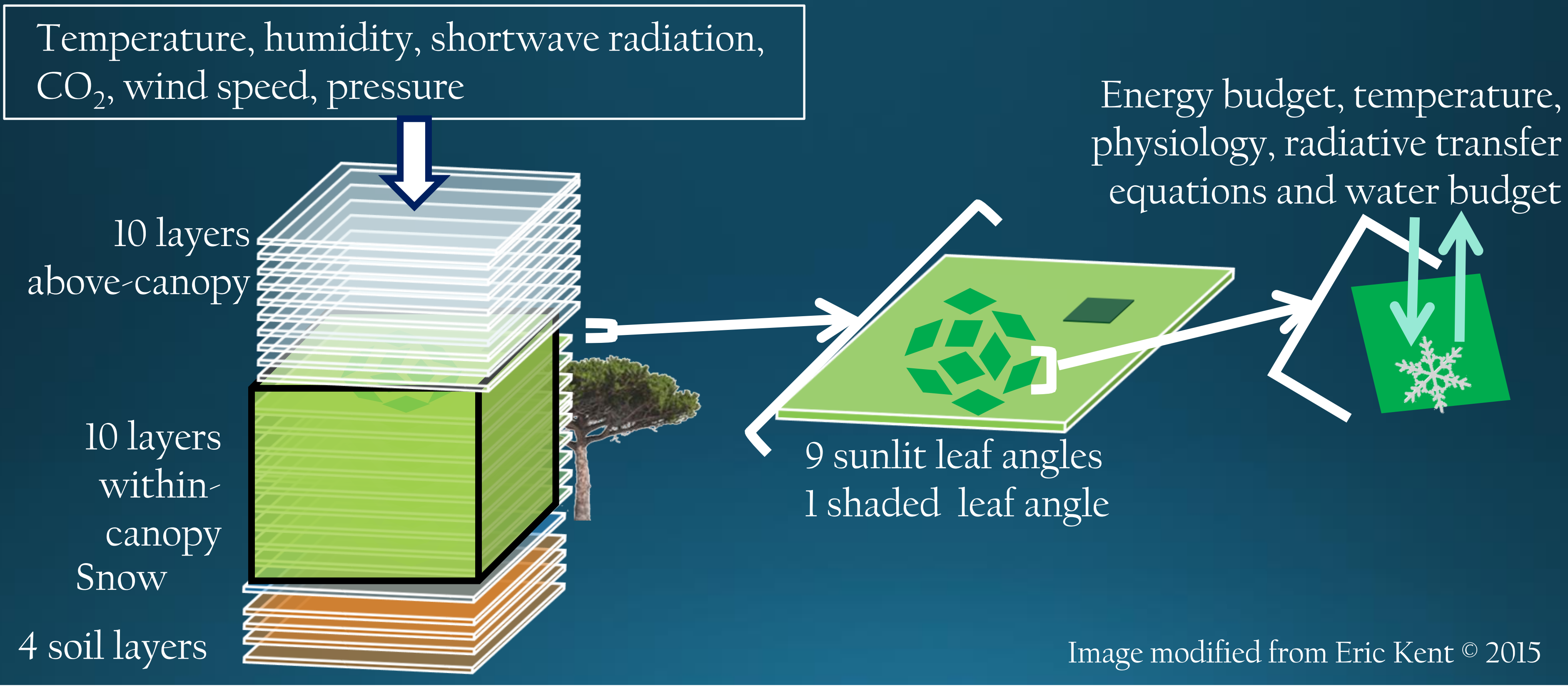
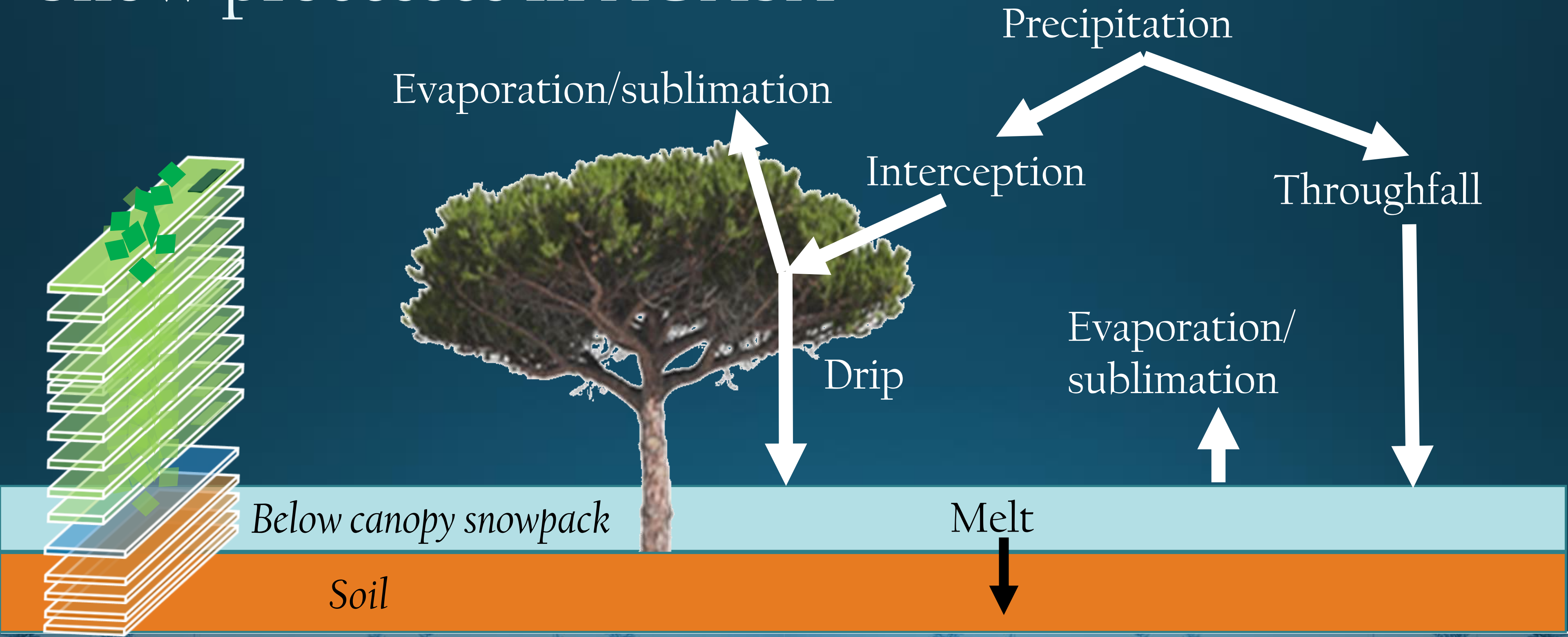


Image modified from Eric Kent © 2015

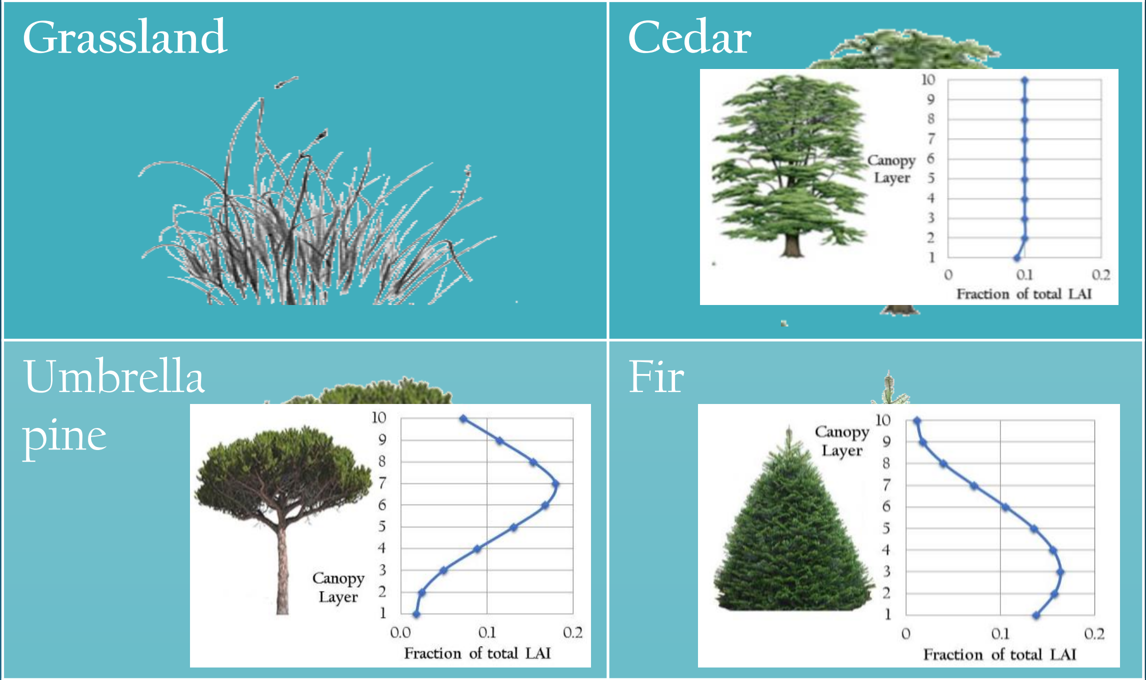
Snow processes in ACASA



Simulated grassland & 3 tree canopy types

Canopy parameters

- 1-sided total plant area indices
- **Canopy architecture**
- Leaf/canopy drag coefficient
- Canopy height
- Near infrared reflectivity
- Visible leaf reflectivity



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Shorter snow season for top heavy biomass structure

Difference in onset of beneath canopy snowpack melt from grassland control (days)

Fir	Larch	Umbrella Pine
		
12	16	18

Evaporation
By 31%

...ter below ...ck depth
1.84
0.53
0.42
Umbrella Pine 0.37

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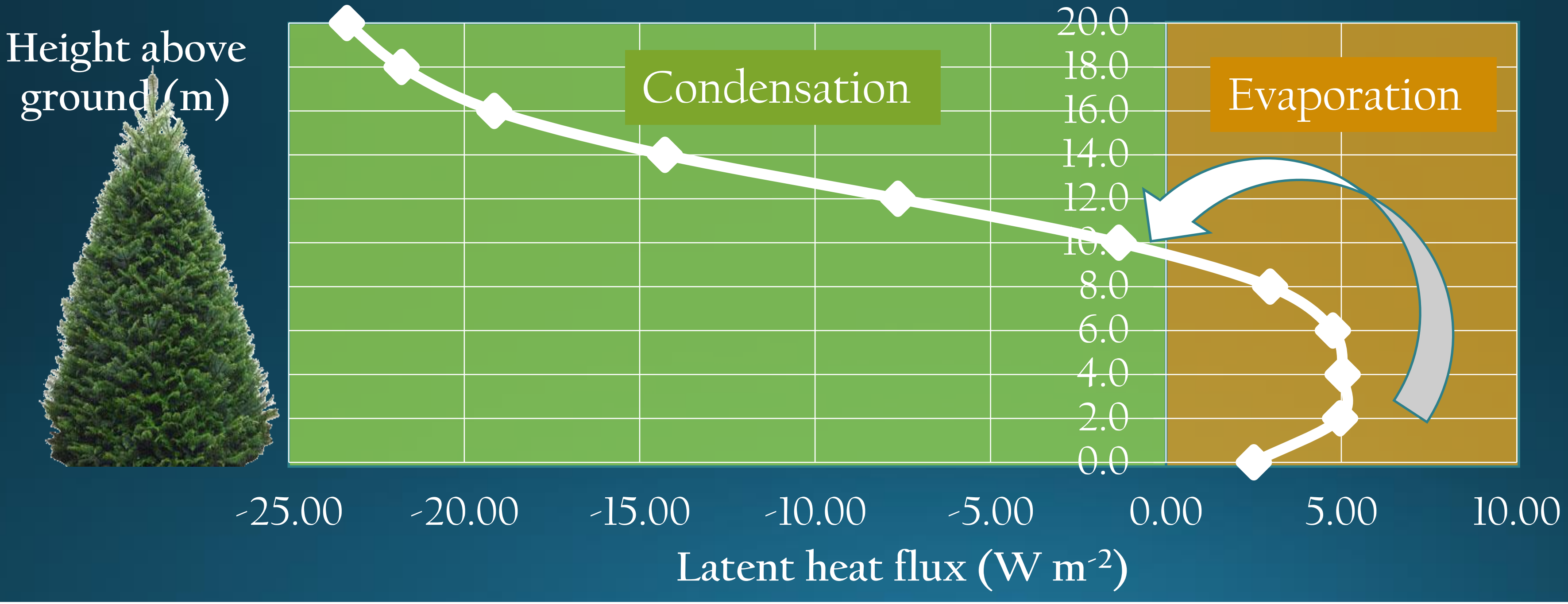
Counter-gradient fluxes occur frequently



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Conclusion

- Model captures vertical distribution of snow
- Shorter duration of snow cover for top heavy canopies
- Counter gradient fluxes frequently occurred and their significance should be investigated further
  - Potential misattribution/estimation errors from single gradient assumptions

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