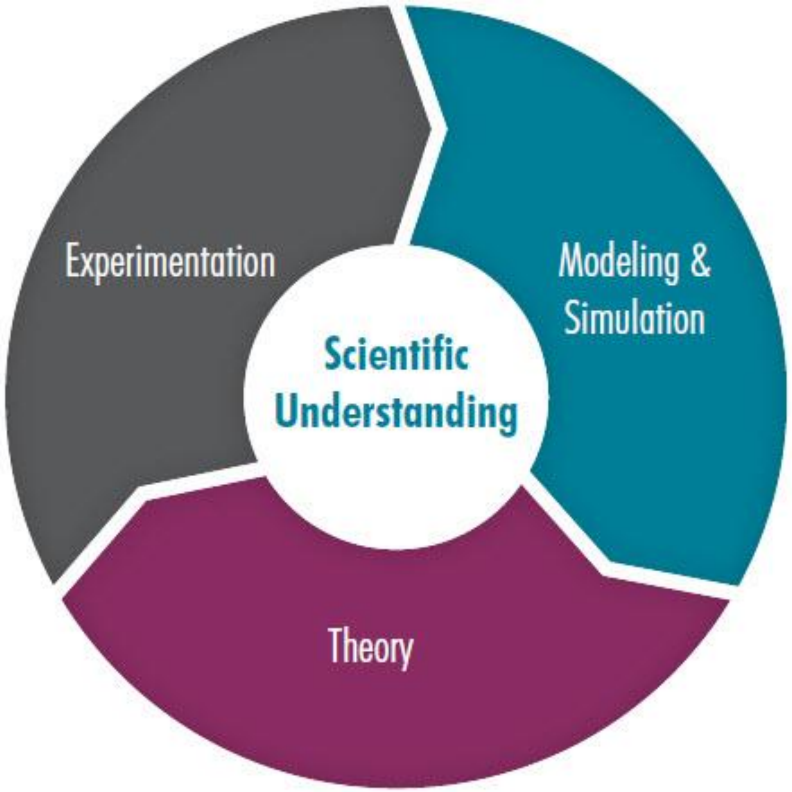
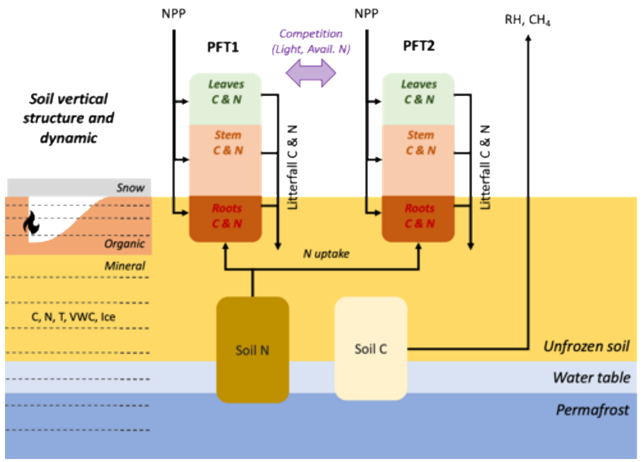
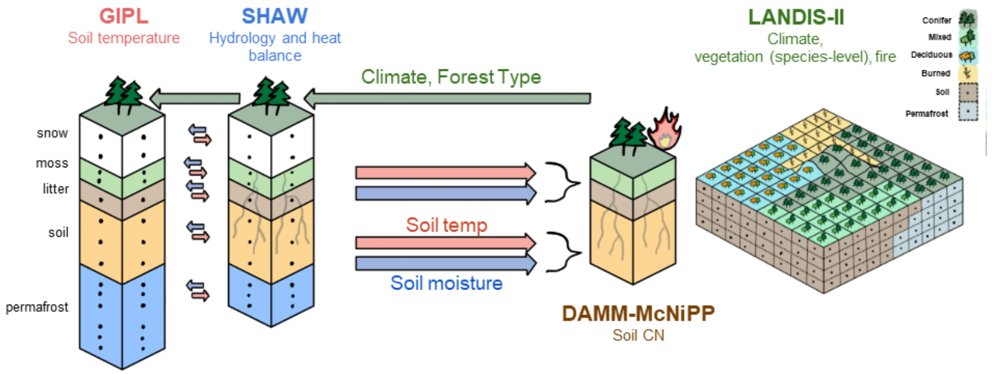
BNZ LTER ecosystem modeling group



DVM-DOS-TEM

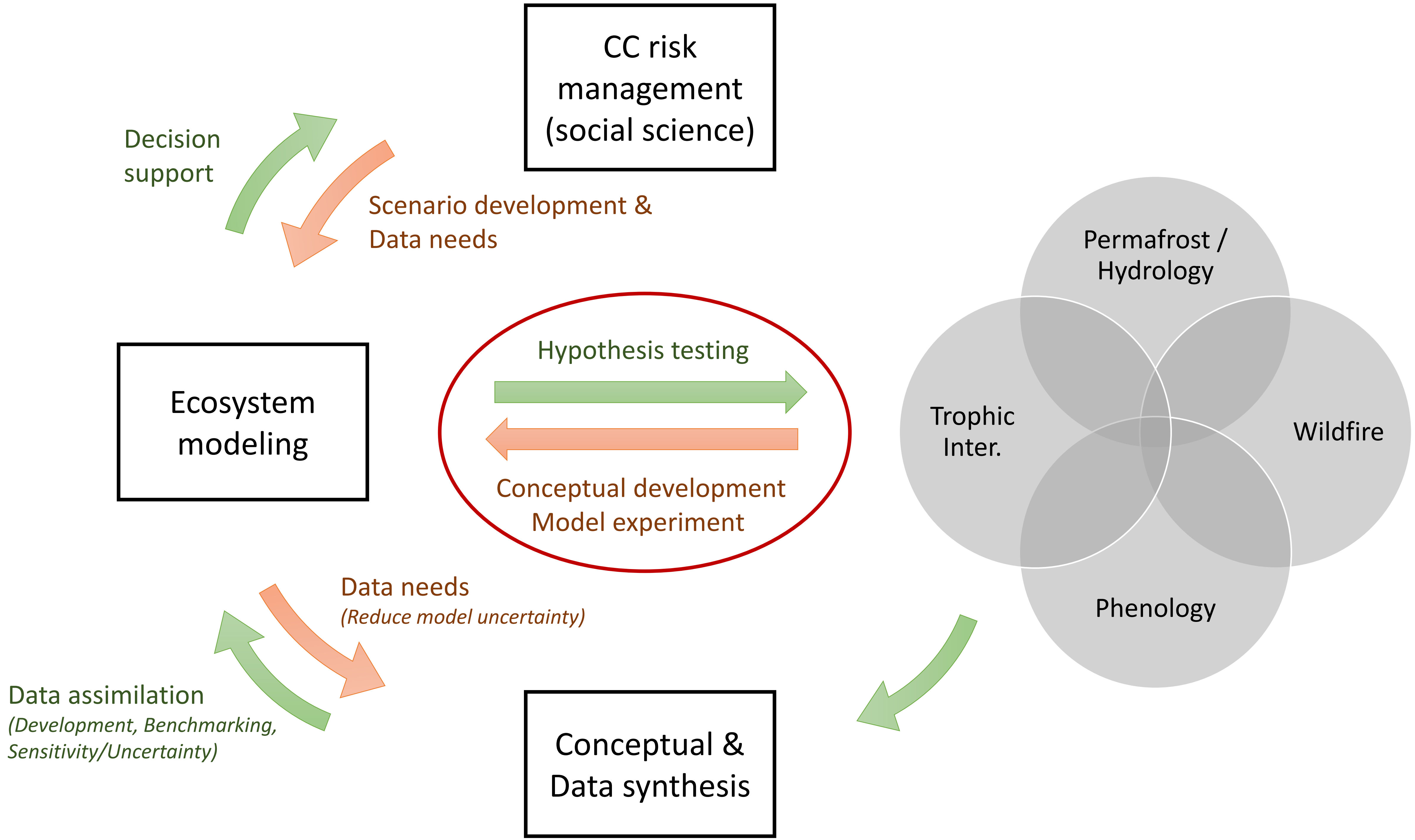


LANDIS-II



ILand

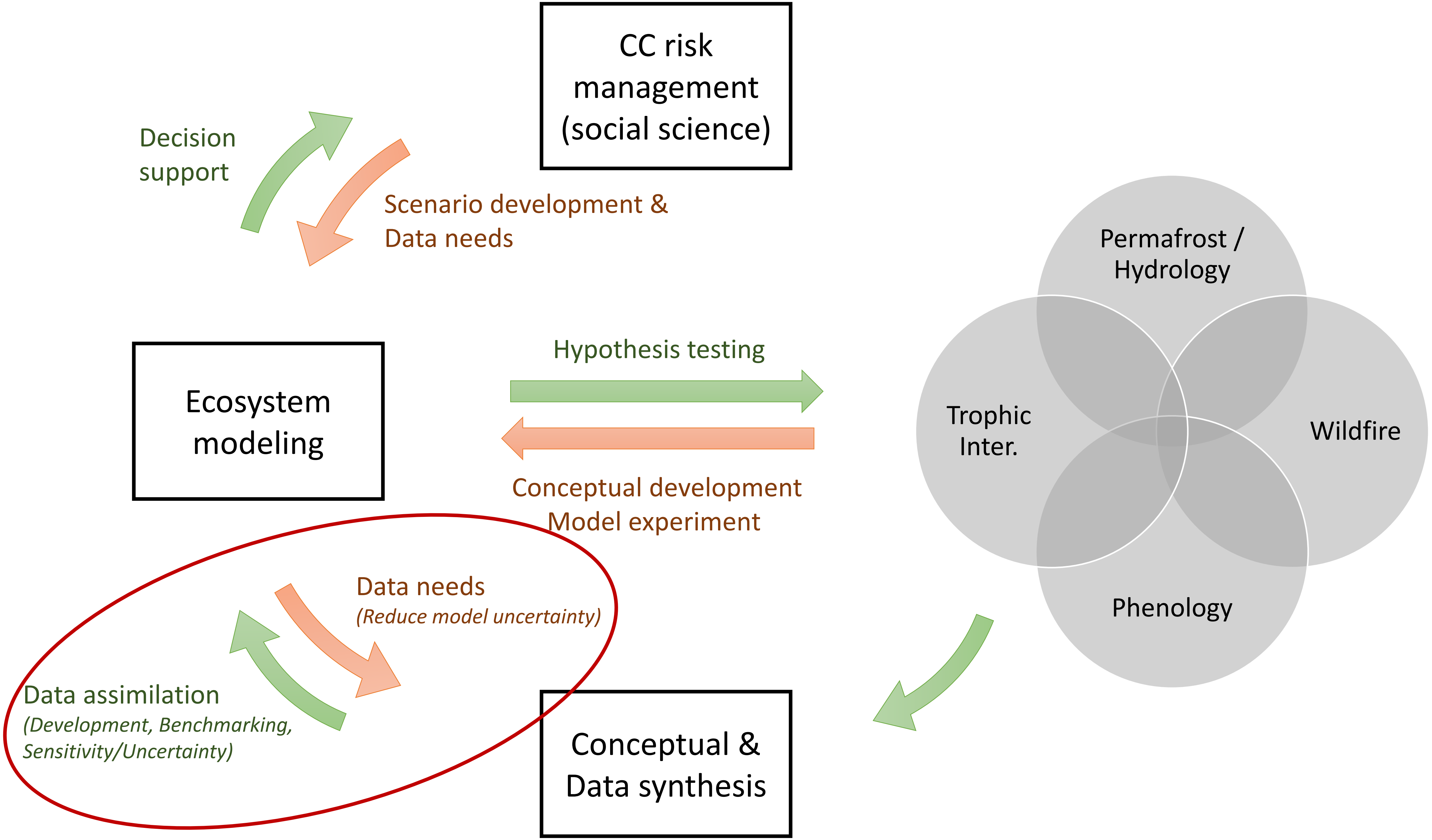
Spatial domain	>1M km^2	120,000 km^2	600 km^2
Spatial res.	site / 1km^2	200m	2m
Temporal res.	Monthly	Daily	Daily
Primary focus	Carbon balance, permafrost	C, Vegetation, hydrology, permafrost	Vegetation dynamic
Disturbance	Wildfire, drought	Wildfire/Rx, drought, insects	Wildfires, biotic disturbances, drought
Vegetation structure	PFT	Individual species cohorts	Individual trees
Soil structure	Multilayers	Multilayer (down to ~75m)	
Land cover	Forest, Wetland, Tundra	Forest	Forest


CC risk management (social science)
Decision support
Scenario development & Data needs
Ecosystem modeling
Hypothesis testing
Conceptual development
Model experiment
Permafrost / Hydrology
Trophic Inter.
Wildfire
Phenology
Data needs
(Reduce model uncertainty)
Data assimilation
(Development, Benchmarking, Sensitivity/Uncertainty)
Conceptual & Data synthesis

- **How do thermal, information, and material legacies shape future ecosystem trajectories of change in the boreal forest?**
  - How is the vulnerability of soil carbon stocks to permafrost thaw affected by disturbance regimes (disturbance type, frequency, severity) in contrasted drainage conditions (upland vs lowland)? How is permafrost carbon loss partitioned between lateral transport, heterotrophic respiration and methanogenesis in uplands and lowlands?
  - How are the legacies of pre-fire soil organic matter composition impact post-fire soil carbon dynamics? How are these legacies affected by fire characteristics (severity, frequency, reburn) ?

- **At what spatial and temporal scales are these legacies important to represent?**
  - How does permafrost thaw affect soil hydrological regimes? What are the implications for soil carbon dynamic and vegetation productivity?
  - How does talik formation affect soil hydrology, nutrient availability and carbon dynamics?
  - What is the contribution of species-specific plant (and insect?) phenological change/plasticity to seasonal and long term energy balance at local and regional scale?
  - What is the importance of moss and snow dynamics as a determinant of the vulnerability of permafrost to climate change?

- **What are the long term consequences of shifting disturbance regimes on ecosystem structure and functions?**
  - To what extent can drought, defoliator outbreaks and pathogens affect the persistence of alternative successional pathways and fire self-regulation? How do post-fire alternative successional trajectories affect the regional energy balance (including albedo)?
  - How will the compound effects of multiple disturbances unfold in response to various climate change? How will this shape ecosystem/landscape dynamics in the next 100 to 300 yrs?
  - What is the importance of wildfire on the risk of abrupt thaw and what are the consequences for ecosystem structure and function?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Conceptual & Data synthesis

- **Model intercomparison of historical and future simulations** of vegetation, permafrost and carbon dynamics in some of the core sites, regional site network and CAFI/FIA sites will help improve model uncertainty assessment.

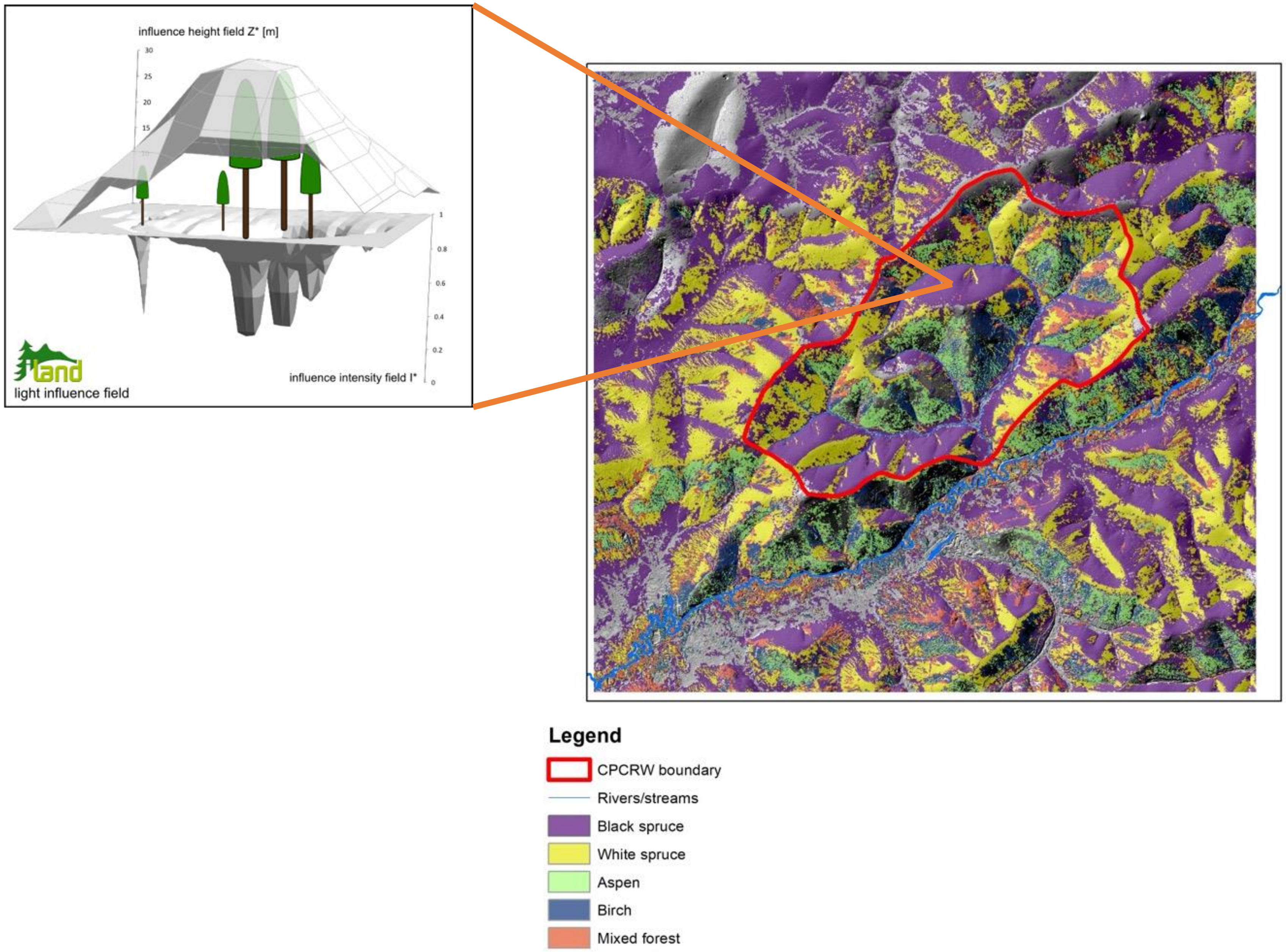
- **Using functional benchmarking on the three ecosystem models** will contribute to better understand the influence of model structure on model performance to represent some of the critical processes driving vegetation, permafrost and carbon dynamics in boreal ecosystems.

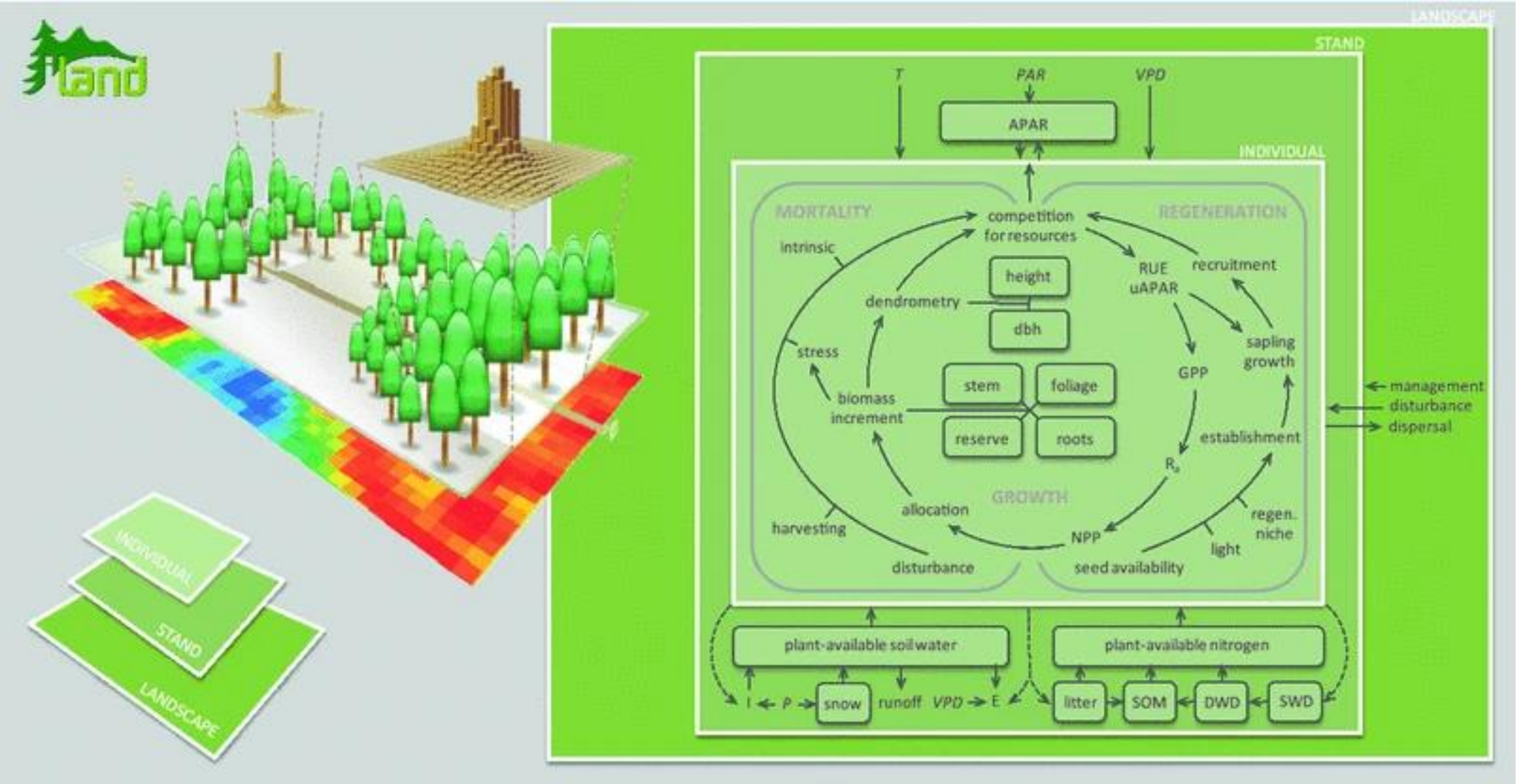
- **Targeted sensitivity analysis** could also help inform data needs to improve model performances.

Collaborative modeling activities

- Collaboration with the other working groups to develop modeling activities in line of each group’s research directions, thus optimizing the integration of ecosystem modeling in the conceptual framework of the proposal. [Nov. / Dec. 2021]

- 2-3 meetings / yr to share and discuss modeling advancement with the rest of the team and collect feedbacks.


influence height field Z* [m]
30
25
20
15
1
0.8
0.6
0.4
0.2
0
influence intensity field I*
light influence field
Legend
CPCRW boundary
Rivers/streams
Black spruce
White spruce
Aspen
Birch
Mixed forest



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REGENERATION
GROWTH
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for resources
intrinsic
dendrometry
height
dbh
stress
biomass
increment
stem
foliage
reserve
roots
RUE
uAPAR
recruitment
sapling
growth
GPP
establishment
R_a
NPP
allocation
harvesting
disturbance
seed availability
light
regen.
niche
management
disturbance
dispersal
plant-available soil water
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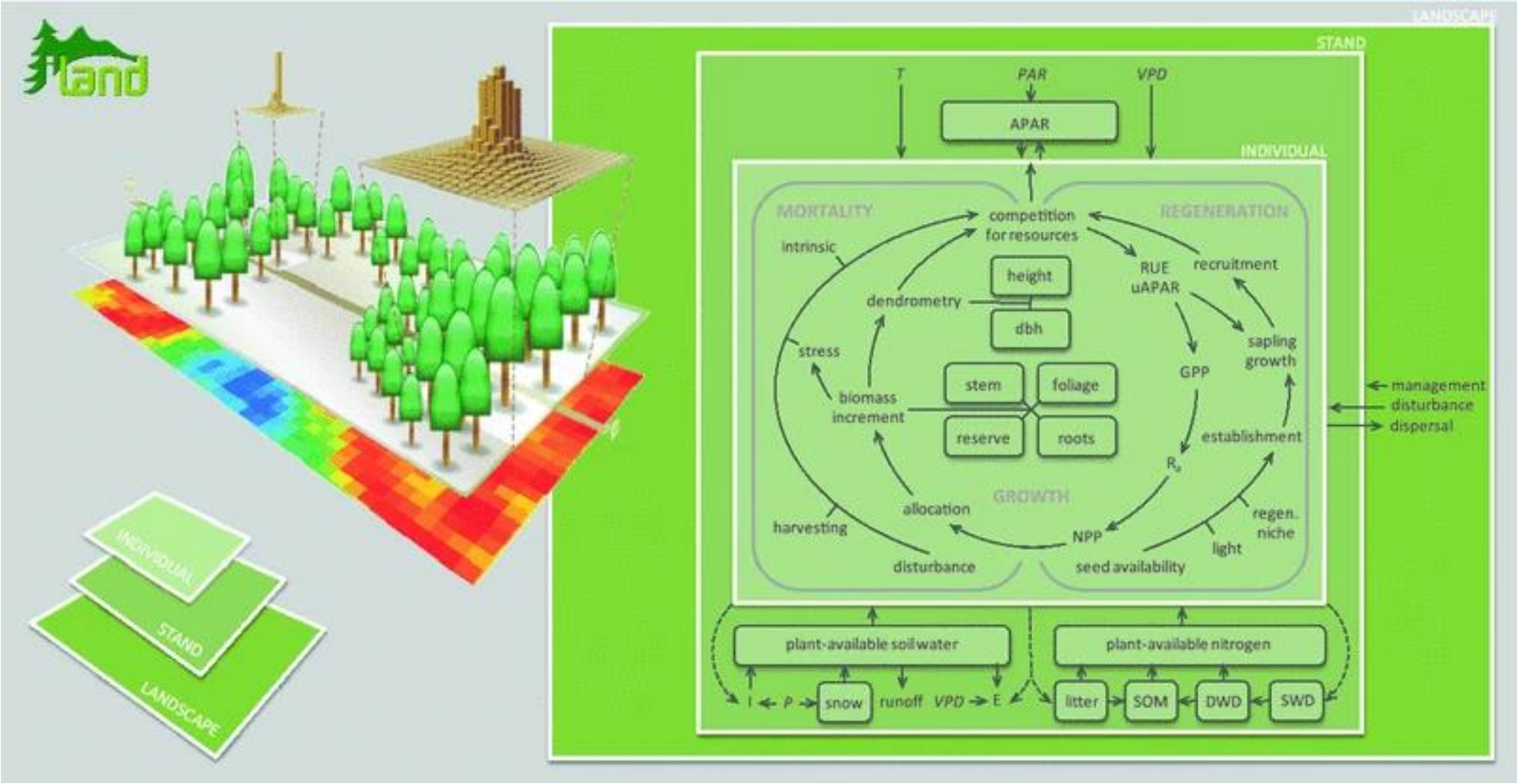


iLand-boreal additions

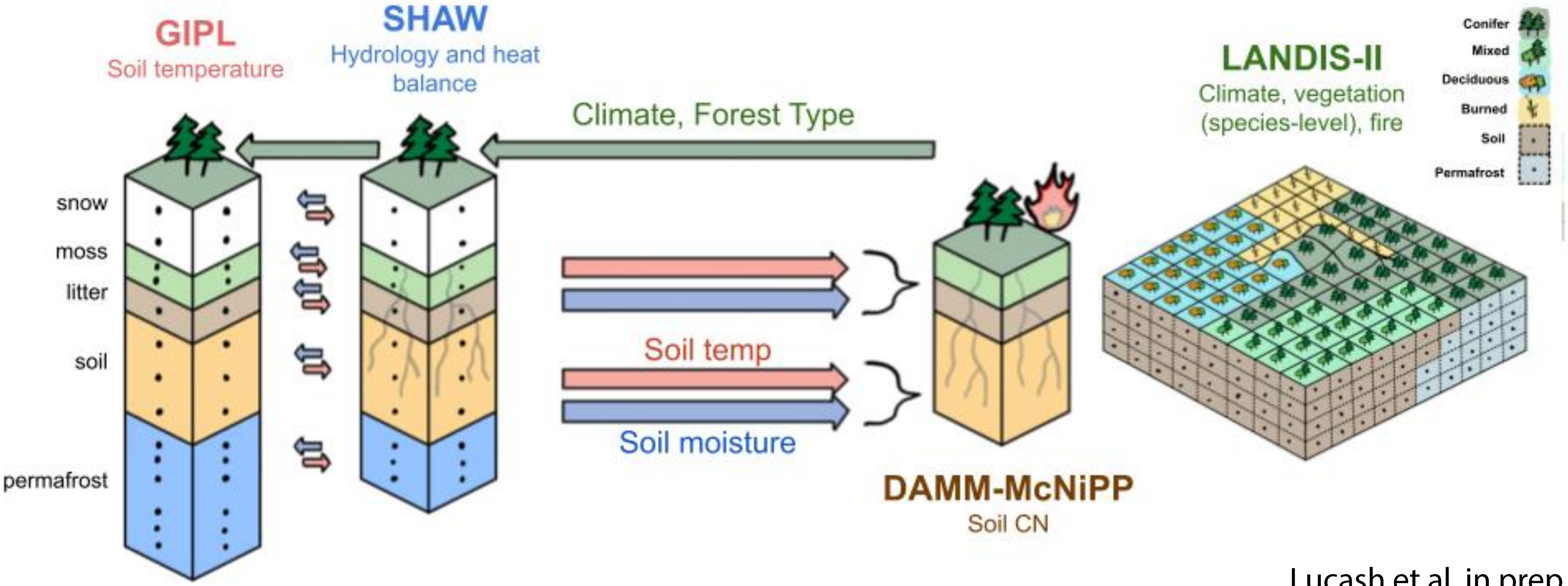
- Moss productivity and decomposition
- SOL accumulation
- Near surface permafrost presence
- Daily active layer depth

Simulating feedbacks between fire, vegetation, soil and hydrology on carbon dynamics in the boreal forests of Alaska

Lucash, Buma, Link, Romanovsky, Vogel, Nicolsky, Scheller Marshall, Shabaga, Hayes and Weiss

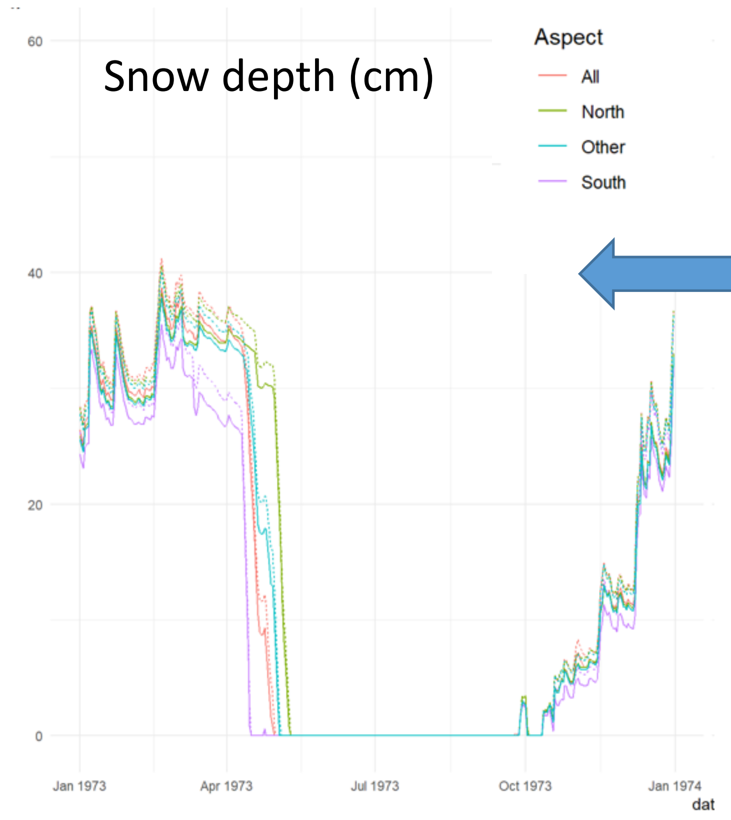
DGS (DiGS)=

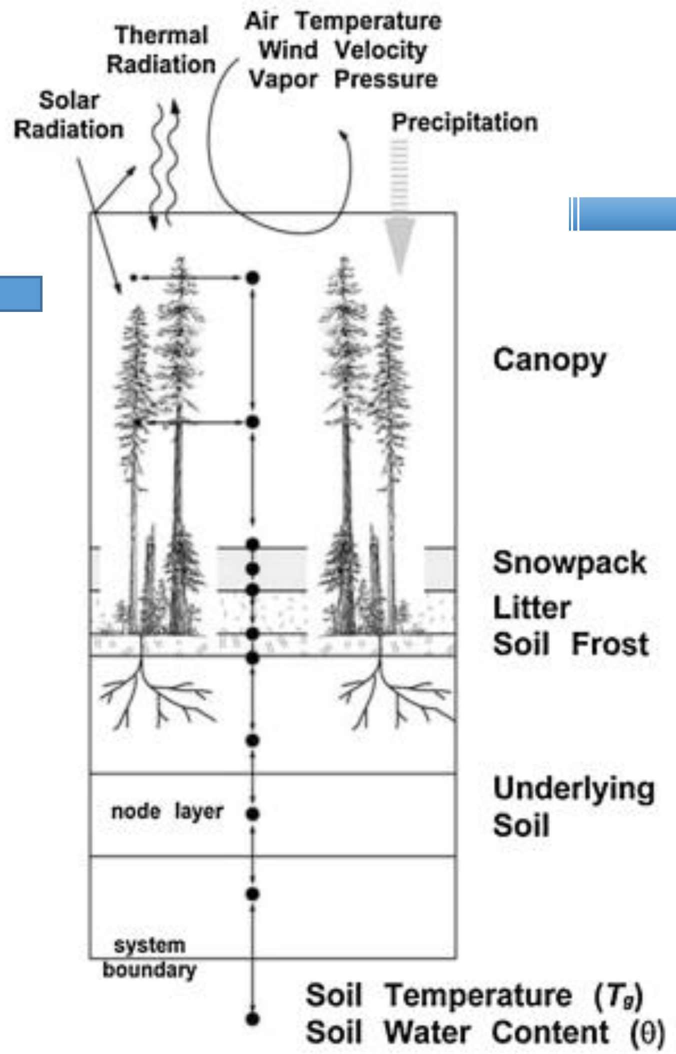
LANDIS-II NECN (veg) + Scrapple (fire) +
DAMM-McNiPP (soil) + SHAW (heat/hydro)

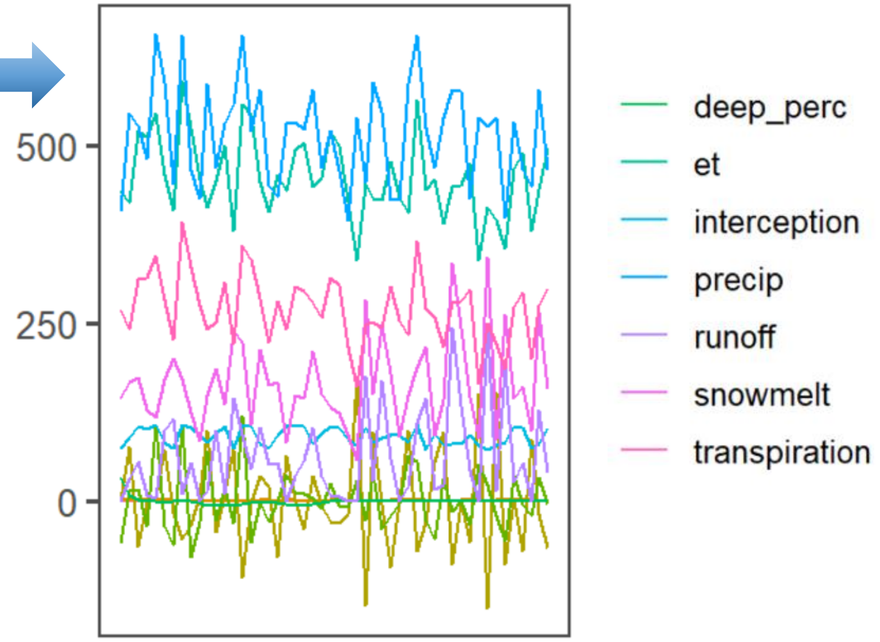


Lucash et al. in prep

SHAW- Simultaneous Heat And Water balance model







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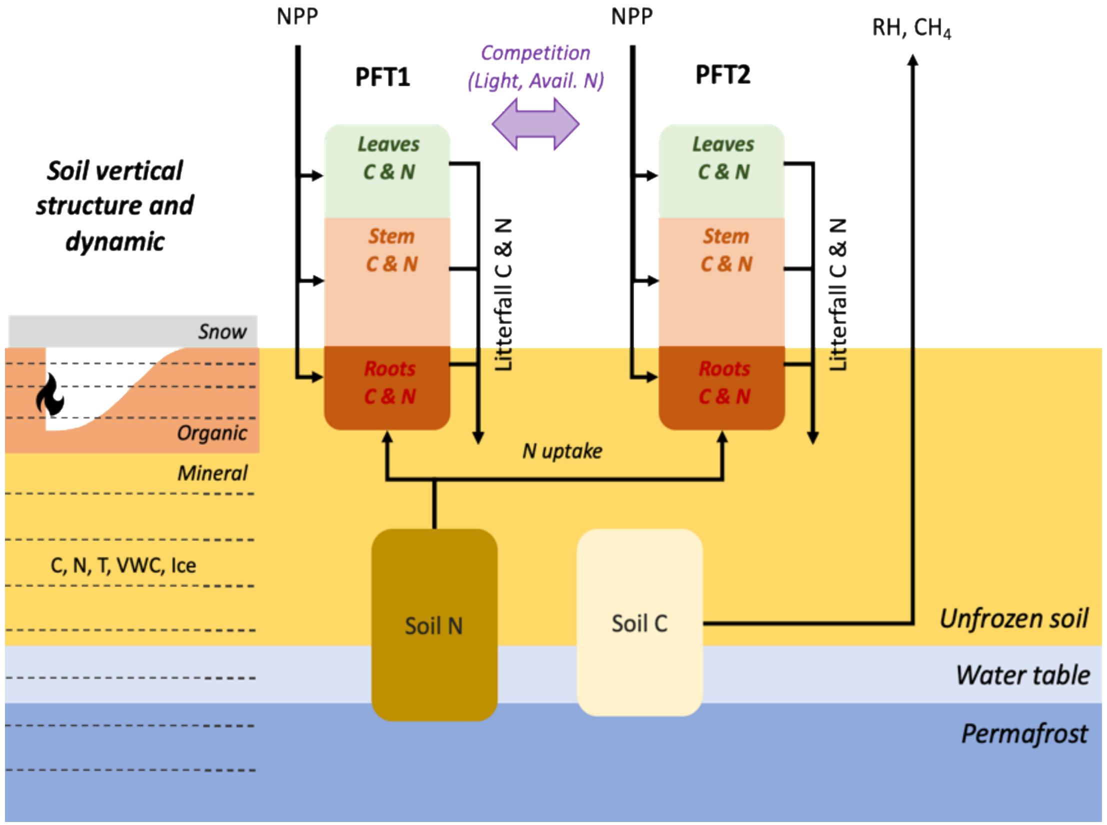


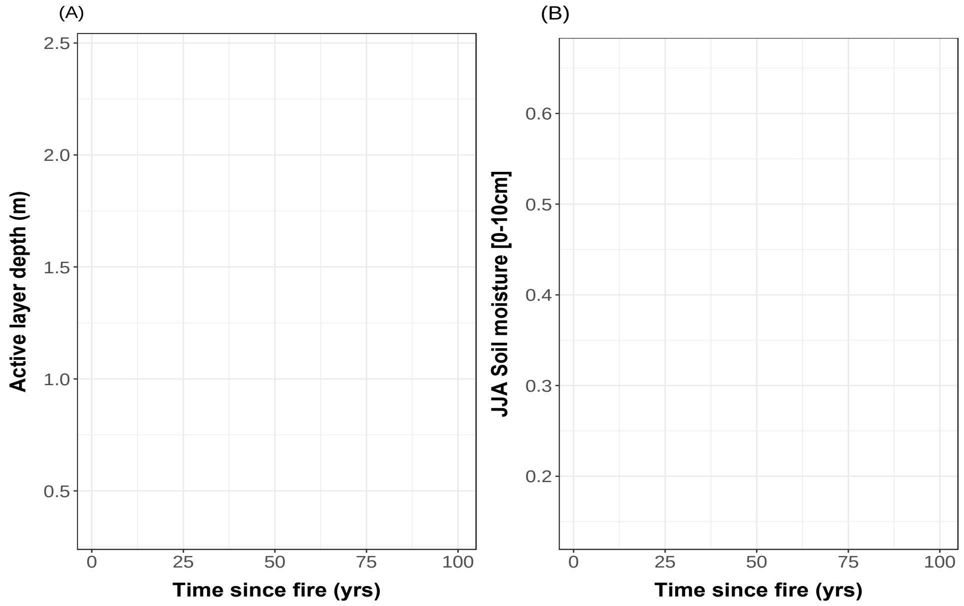


Figure 1: Post-fire dynamic of (A) active layer depth and (B) surface soil moisture from the historical runs. Envelops represent +- standard deviations.

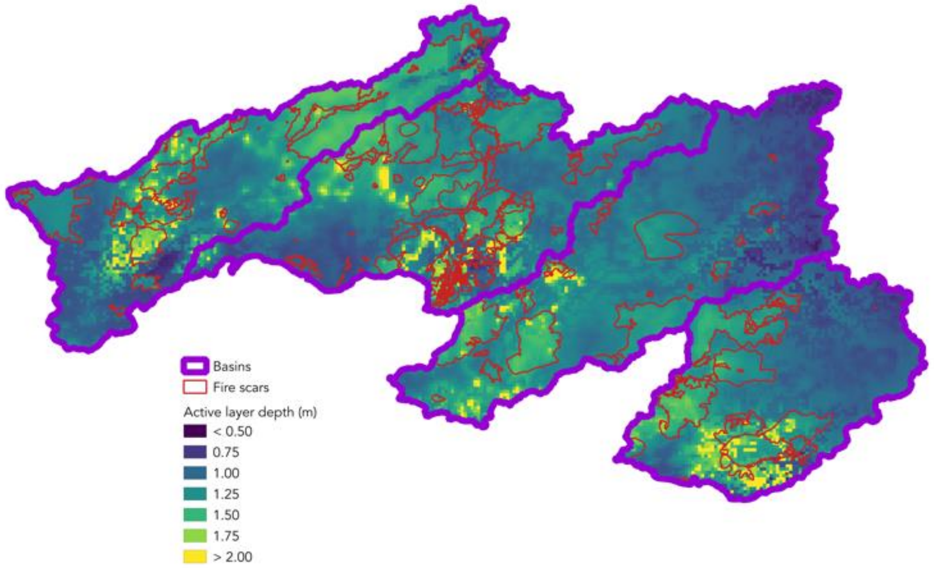
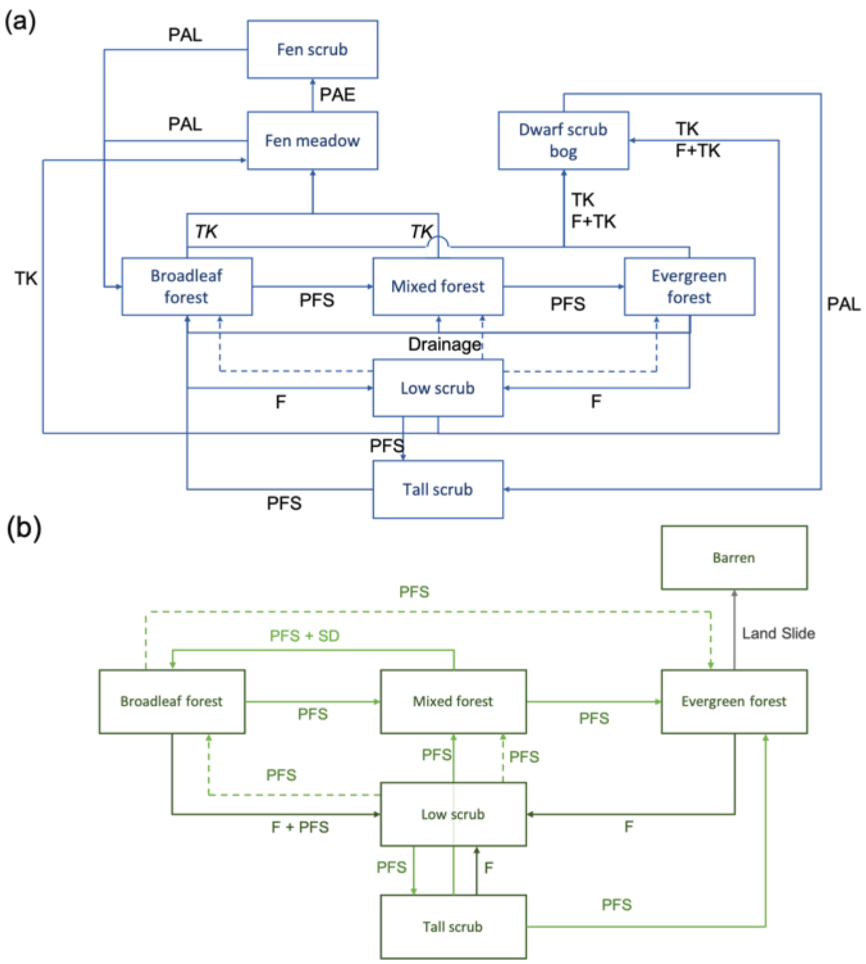
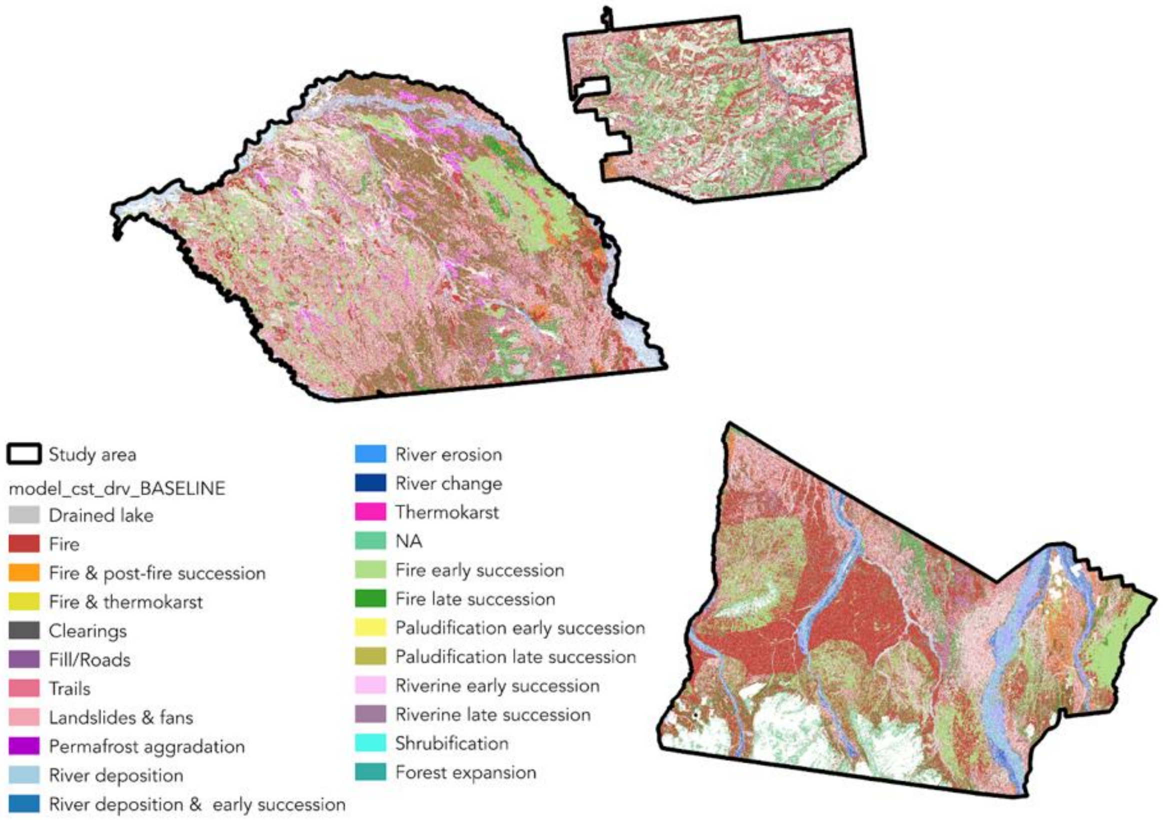


Figure 2: Mean active layer depth [2000-2015] across the area of interest. Areas with deeper permafrost (yellowish shades) correspond to areas that recently burned.

Alaska Disturbance Model



F = fire, PFS = post-fire succession, TK = thermokarst, PAE = early paludification, PAL=late paludification, RD = river deposit, RE = river erosion, PS = post-disturbance succession. *These diagrams have been slightly simplified for clarity sake.*



Vulnerability map for RCP 4.5 emissions scenario (warming trend of 2.7oC/century). Colors locate pixels that experienced land cover change between 2017 and 2100, and the driver of this change.