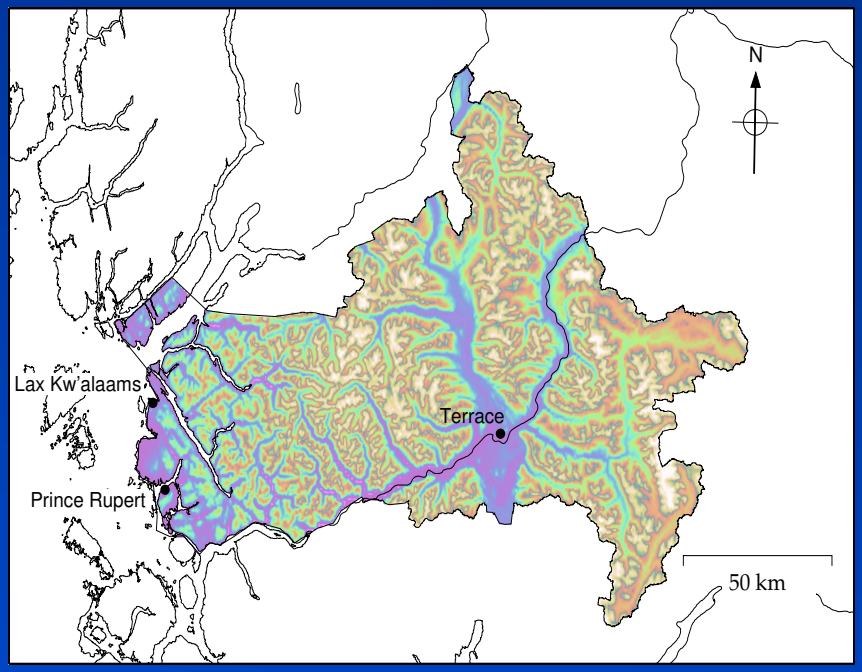
Climate Change Adaptation Planning for Northwest Skeena Communities

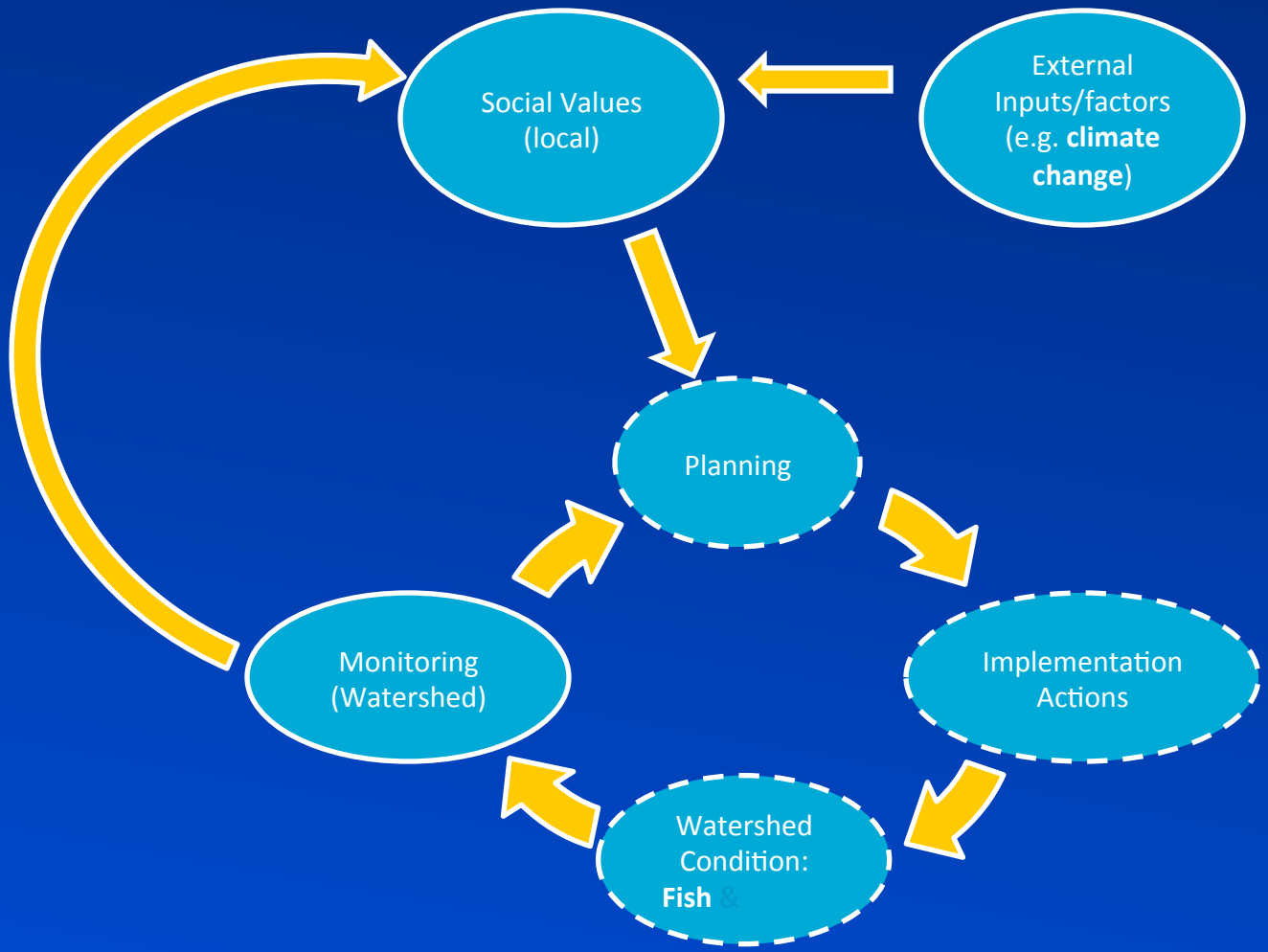
Projected Vegetation Changes



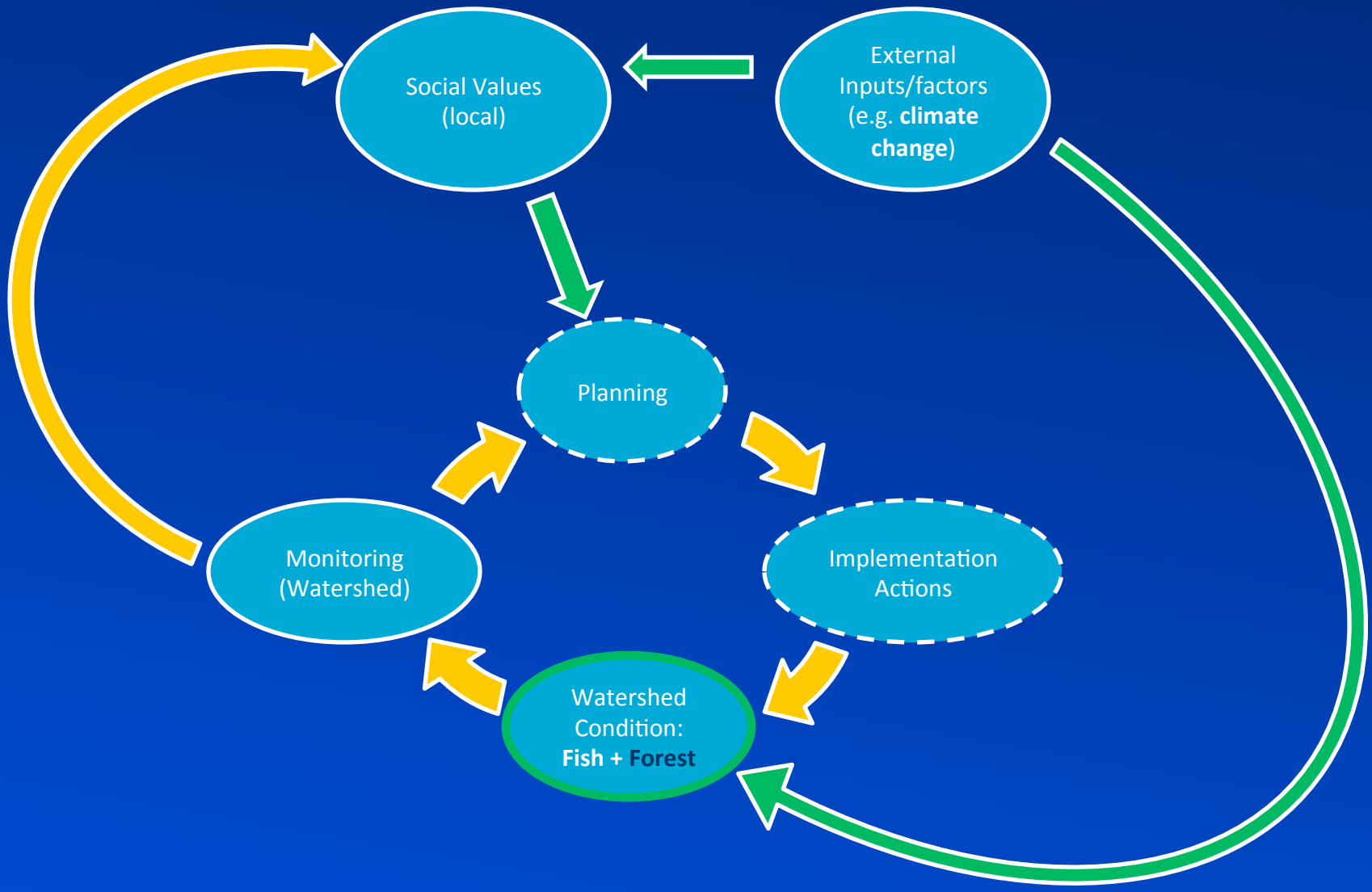
Joe Melton[1], Don Robinson[2], Jed Kaplan[1] & Dave Marmorek[2]

[1] ARVE Group, École Polytechnique Fédérale de Lausanne, Switzerland
[2] ESSA Technologies, Vancouver

Planning… Where Does "Vegetation Change" Fit?



Planning… Where Does "Vegetation Change" Fit?



Why Use a Simulation Model?

Simulation models can help to…
- organize the thinking of many people in a consistent way
- combine, test and refine scientific knowledge
- provide possible answers to “what if” questions
  about the future ***when past experience may not be enough***

Can use current information and knowledge, to cautiously extrapolate to conditions that may not have been seen before

Every time you read a tide-table, check the weather forecast or look at a stand growth curve, you’re checking with a simulation model. You might not trust it totally, but you check it anyway and then make up your own mind.

Introducing… Global Climate Models

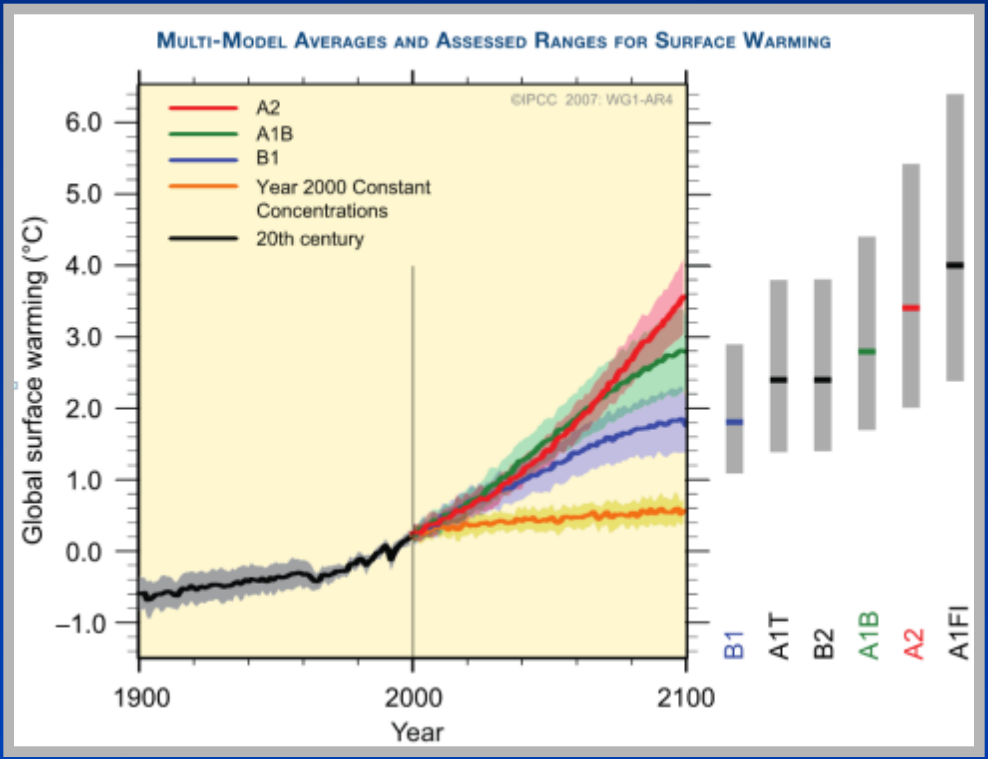
simulate the process of heating, cooling & air movement over entire globe: *GHGs*
multiple air layers & ocean layers
can include sea ice, clouds, vegetation
about 300 km resolution

numerous GCMs: different governments, laboratories and universities involved

United Nations (IPCC) a major contributor: scenarios of future human development, analysis & communication

No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

Introducing… Global Climate Models



No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

Solution 1: use an **average** from multiple GCMs and look for adaptation and mitigation options that do some good under many development scenarios

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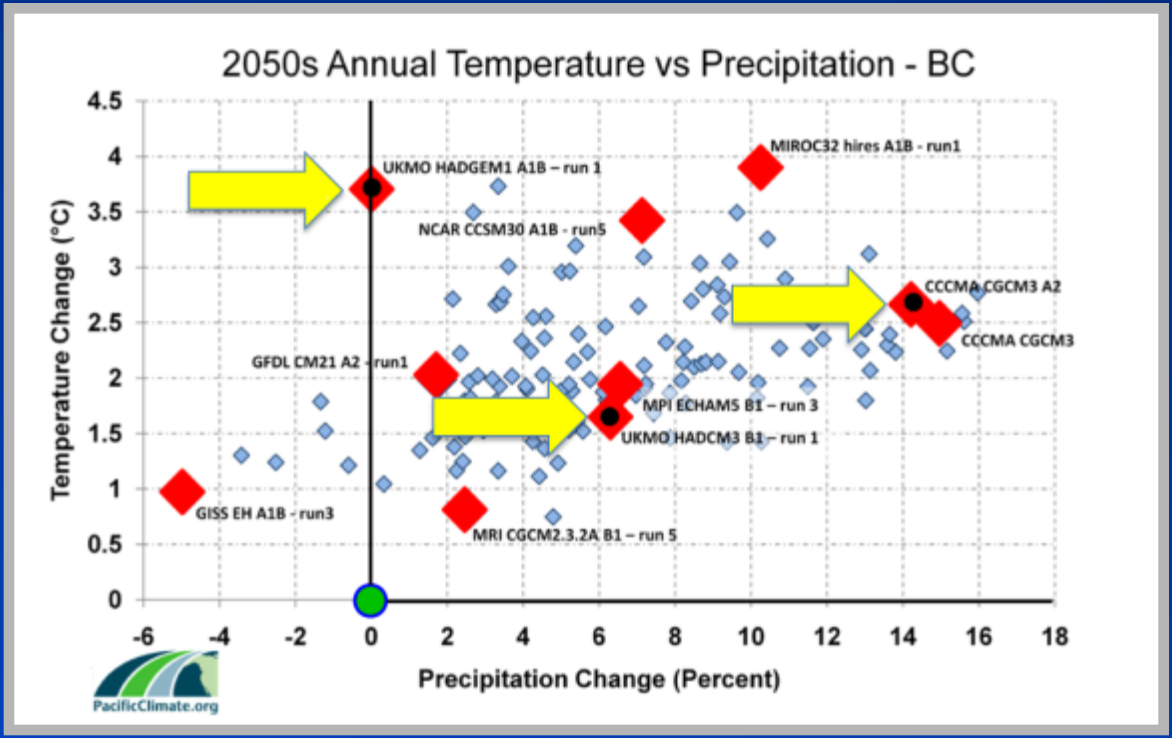

No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

Solution 2: use predictions from a **range of models & scenarios** and look for adaptation and mitigation options that do some good under many development scenarios

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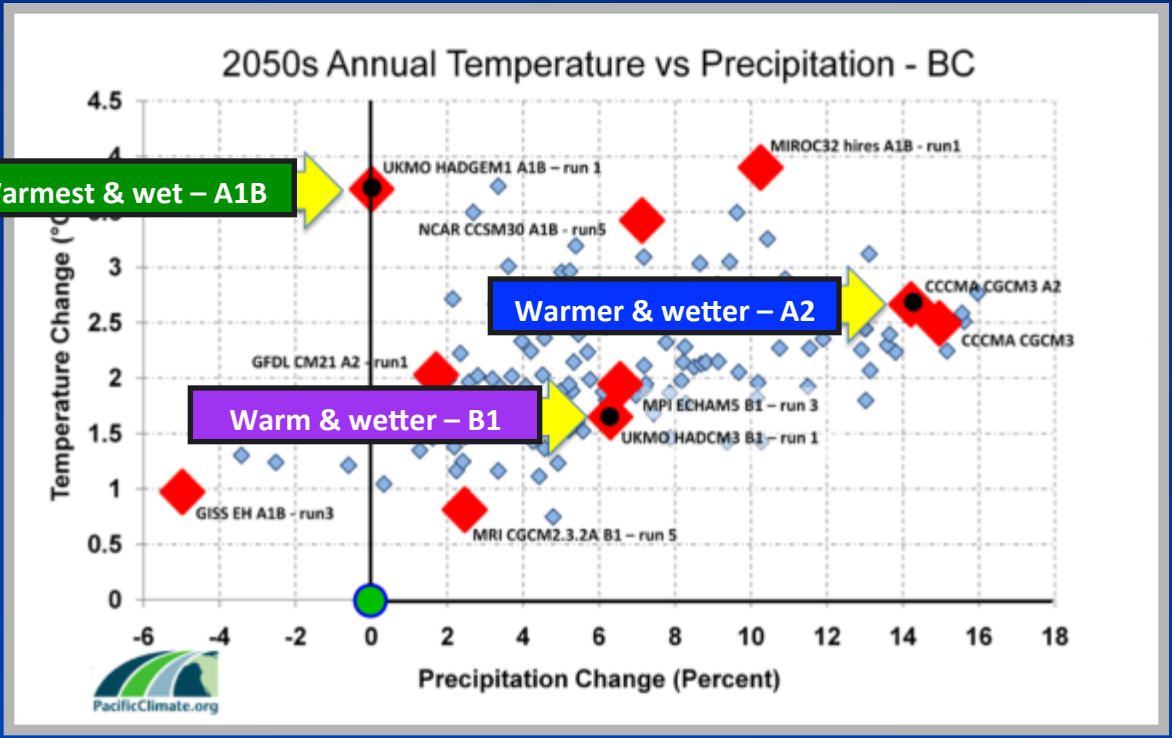

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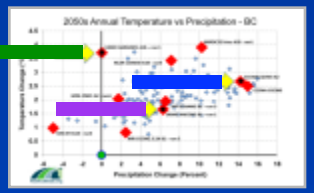
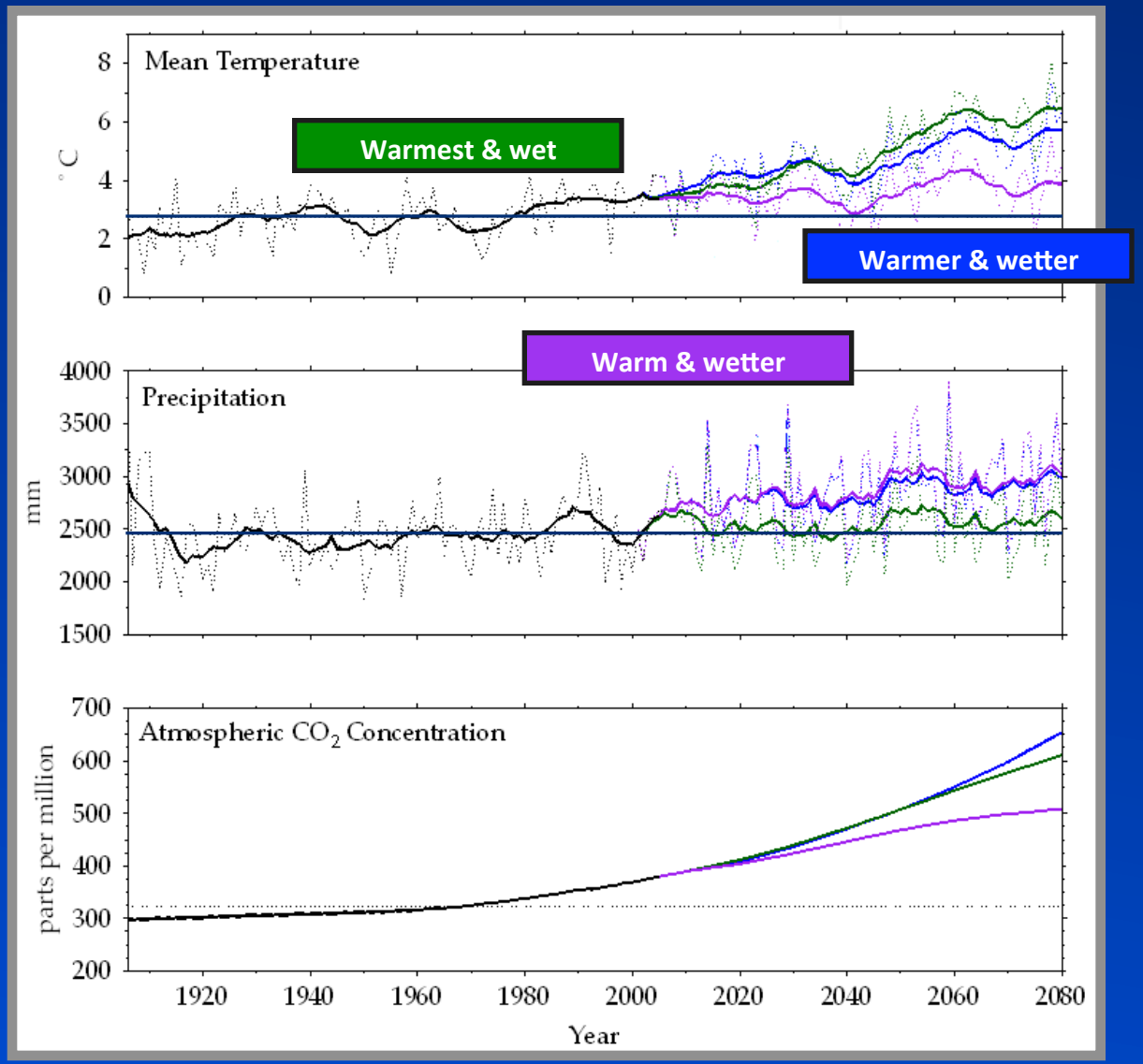
average values over entire region

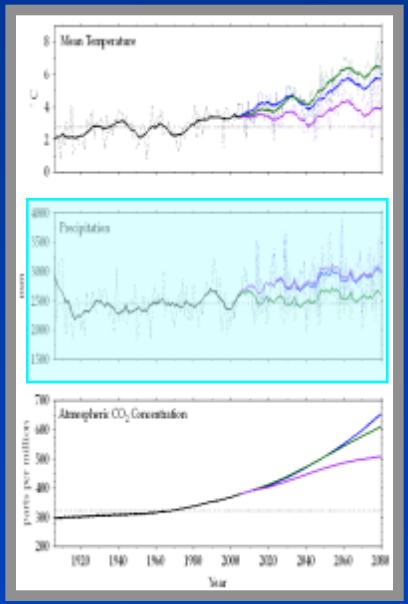


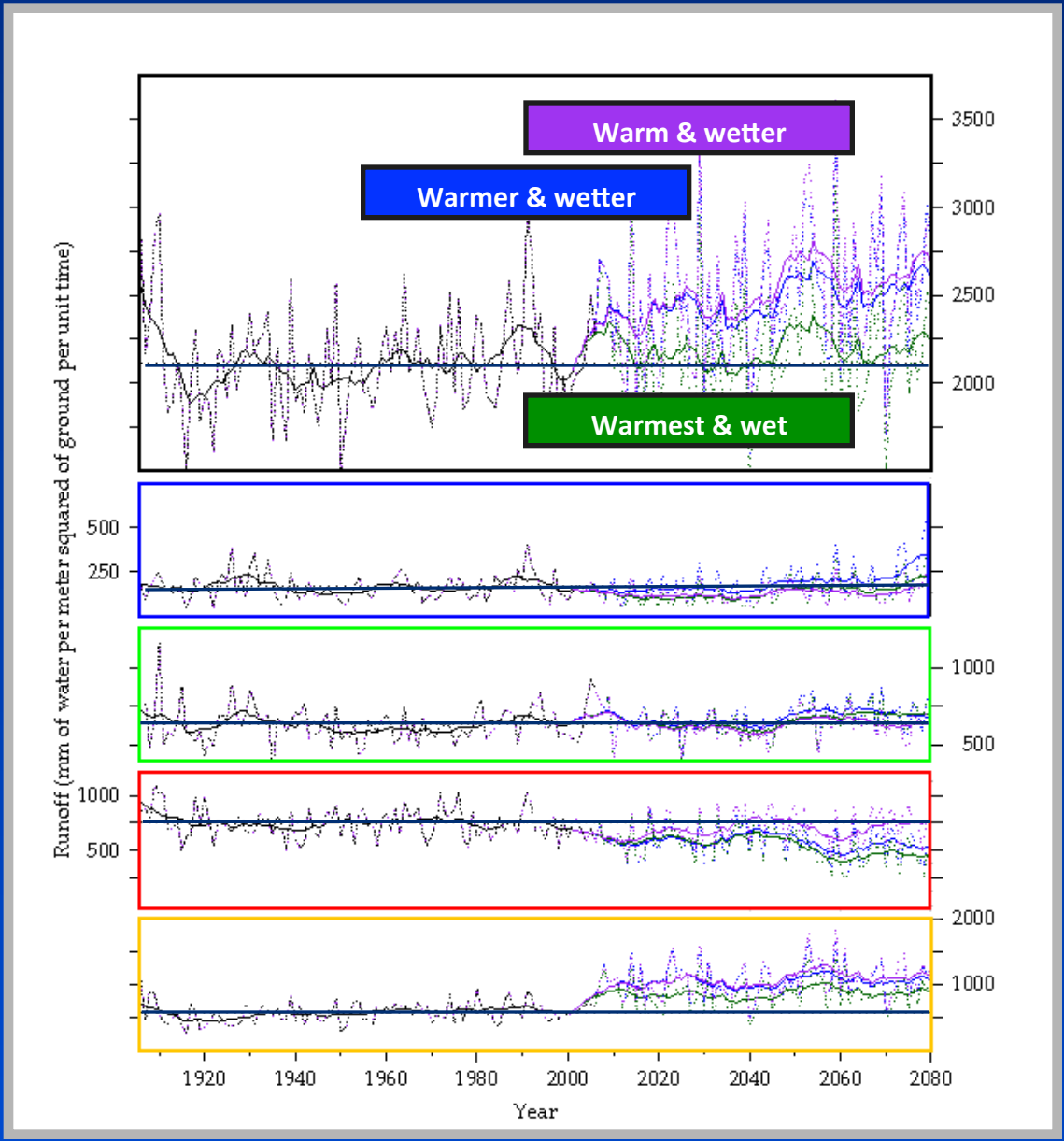
temperature, precipitation, & CO_2 are all fed into the vegetation model



Introducing… Global Climate Models

changes in runoff timing





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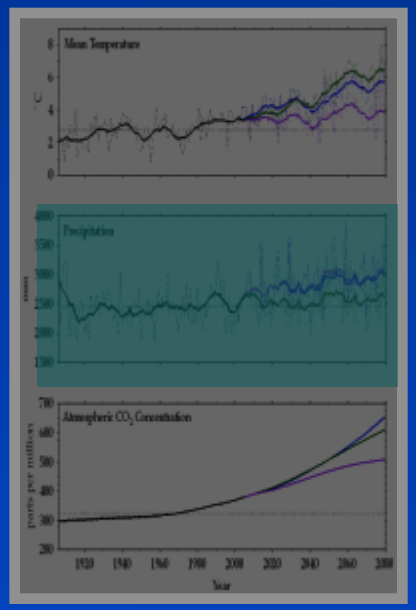
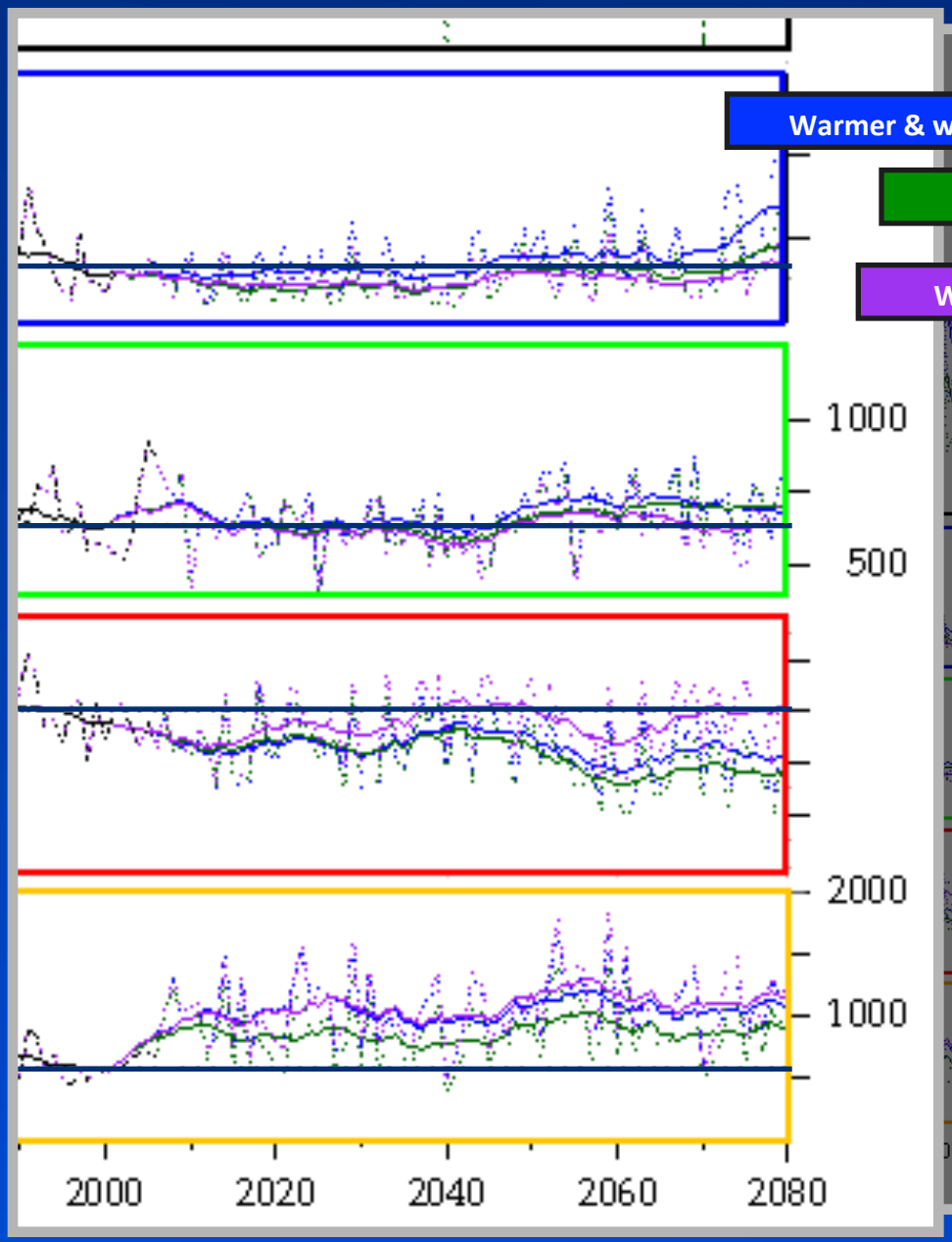




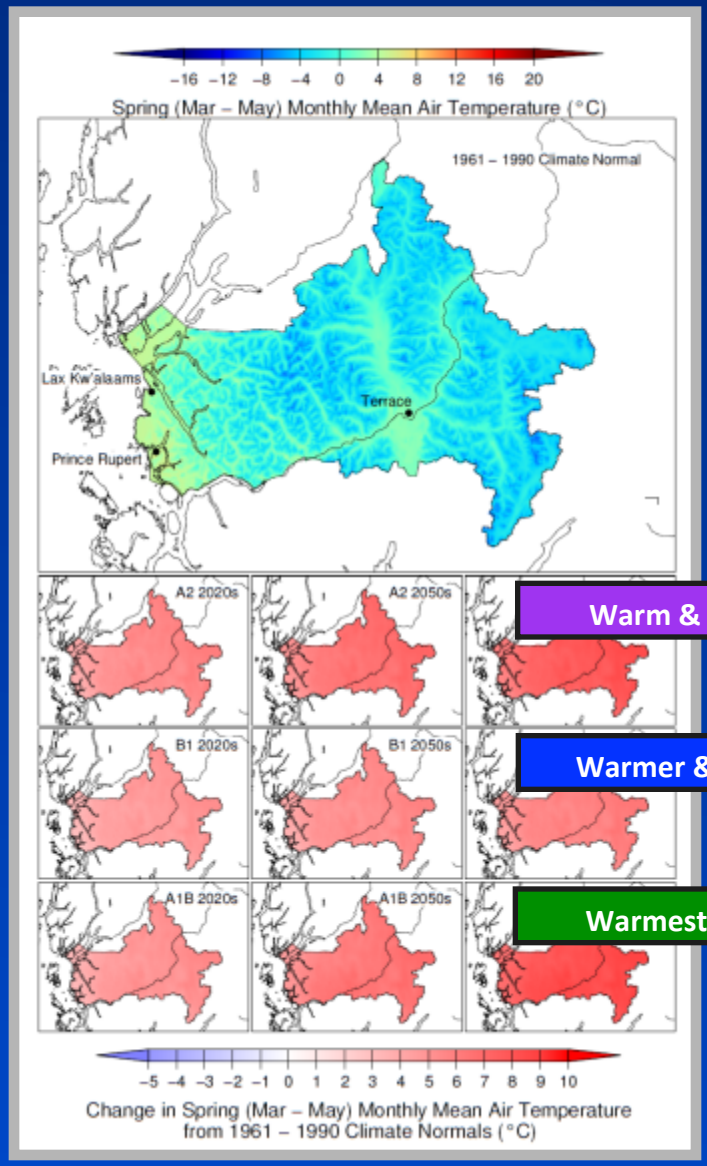
Introducing… Global Climate Models

local conditions "downscaled" from large-scale simulation models

daily pattern based on ***monthly*** averages

may not capture the full range of future conditions

may not capture changes in localized intense weather events like storms, heavy rain or snow, ocean conditions



Introducing… The LPJ-Guess vegetation model

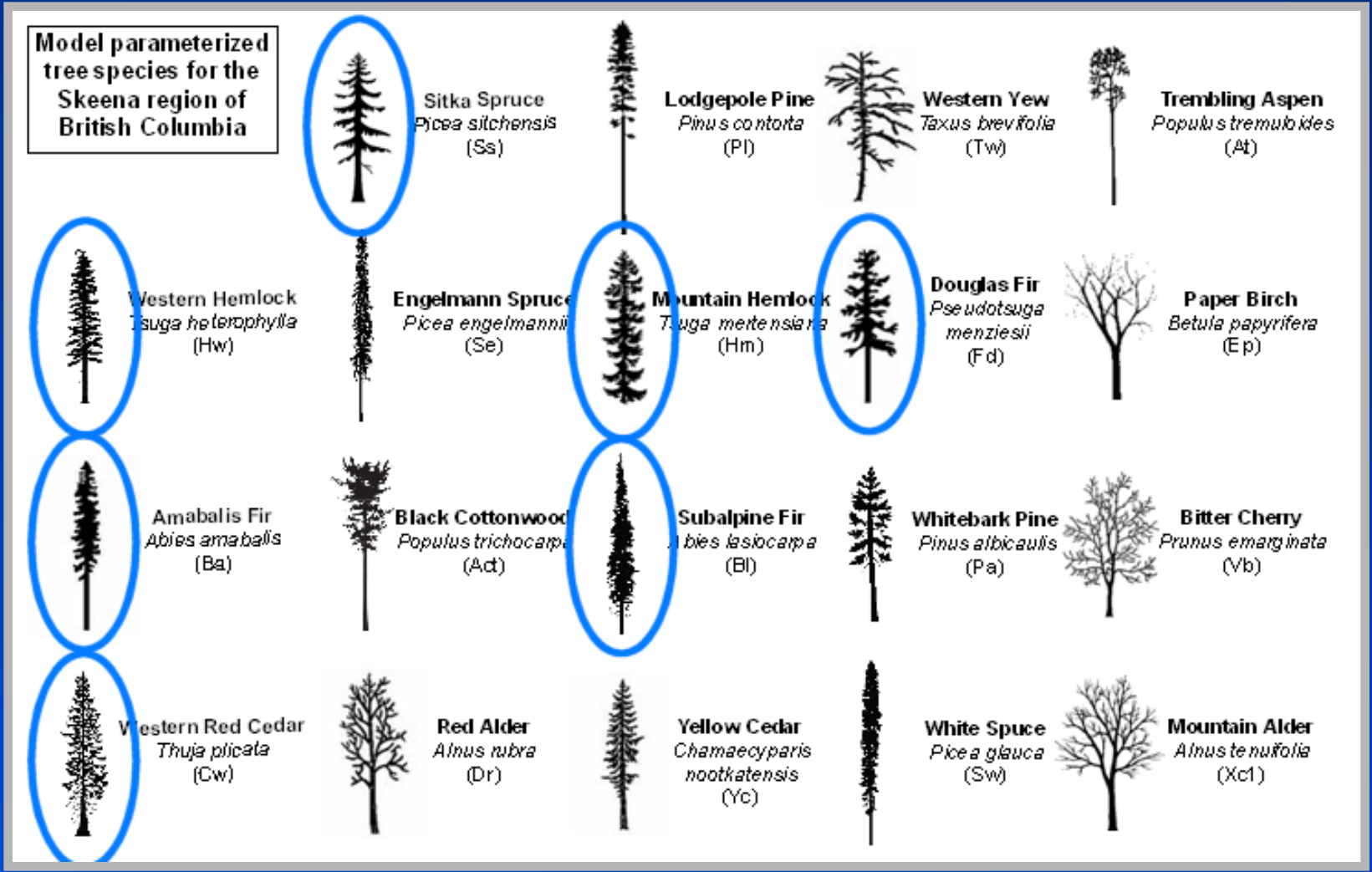
responsive to light, heat, moisture & CO_2
calibrated for about 20 northwest tree species
grows cohorts of trees, plus grass
tree growth sensitive to surrounding stand conditions
allows clearcut and stand-replacing fire with limited spatial detail

works on a 1 km^2 patch of land
uses simulated daily weather data
local weather is downscaled from large-scale models
daily time is based on monthly averages

each year…

predicts amount of each species in each patch
calculates amounts (“pools”) of biomass as Carbon
calculates changes (“fluxes”) among the pools

LPJ-Guess and Trees



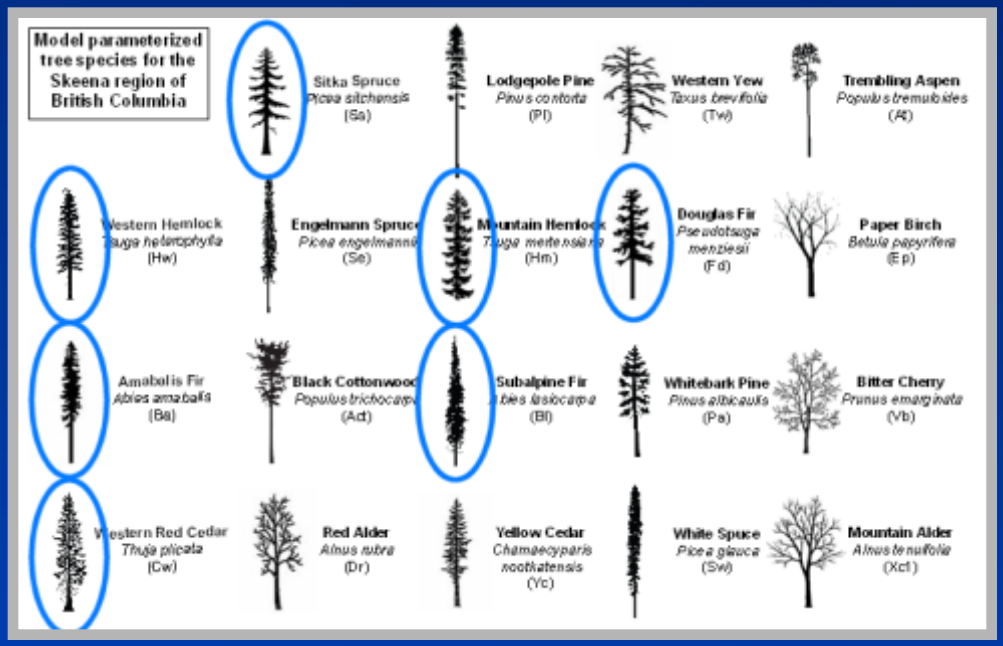
LPJ-Guess and Trees

responsive to light, heat, moisture & CO_2

calibrated for main BC northwest tree species *plus grass*

tree growth sensitive to surrounding stand conditions

allows clearcut and stand-replacing fire with limited spatial detail



Main species…

western & mountain hemlock
Douglas-fir
western red-cedar
Sitka spruce
subalpine & silver fir

LPJ-Guess and Climate

daily pattern based on ***monthly*** averages

may not capture the full range of future conditions

works on a 1 km^2 patch of land

uses ***simulated*** daily weather data

local weather is downscaled from large-scale models

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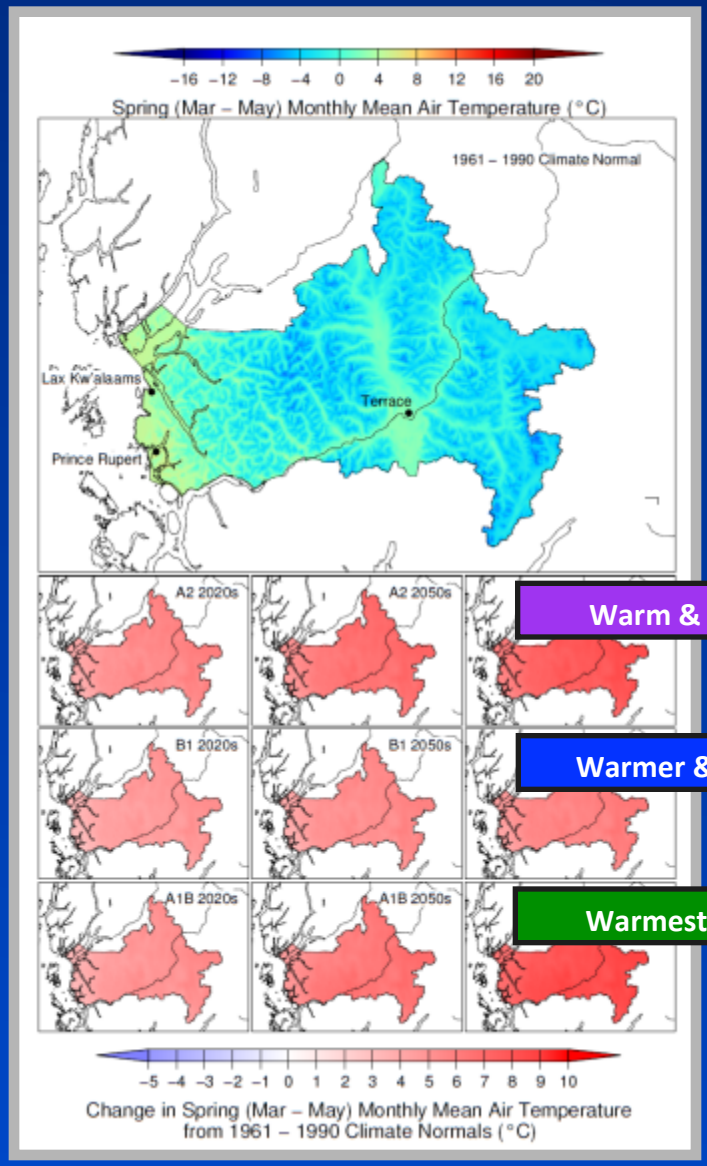


Warm & wetter

Warmer & wetter

Warmest & wet

LPJ-Guess and Shifts in Tree Species

The following 4 animated cartoons show shifts in suitability for 3 common species, and grasses

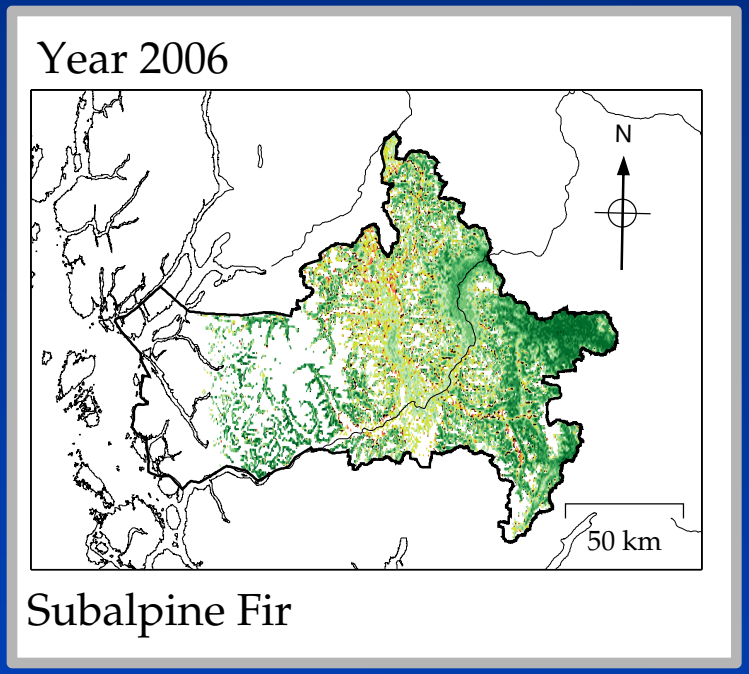
subalpine fir – spreads west and up slopes
mountain hemlock – is displaced by balsam fir
grass – alpine grass displaced by trees
western redcedar – eastward migration possible

Note that orange-yellow colours signal a very small proportion of occupancy: “just arrived” or “just leaving”

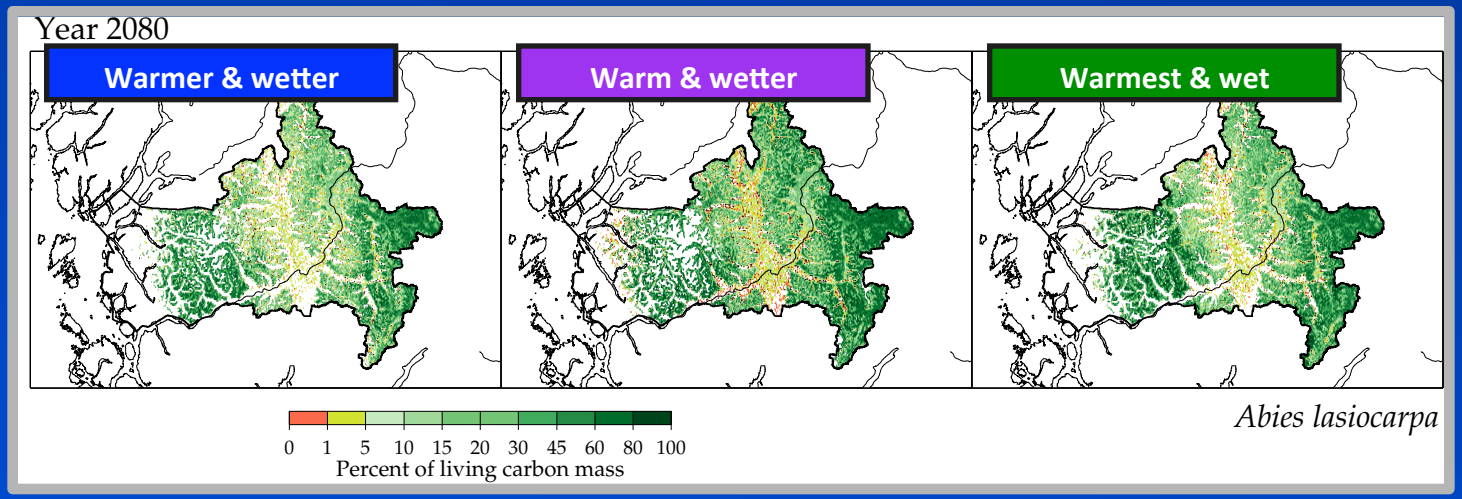
LPJ-Guess and movies don’t actually simulate ***migration*** or what is on the ground: they show changes in potential or suitability…

- “subalpine fir would grow well here”
- “trees would do well here and could replace meadows”
- “should we replant after harvest with something different?”

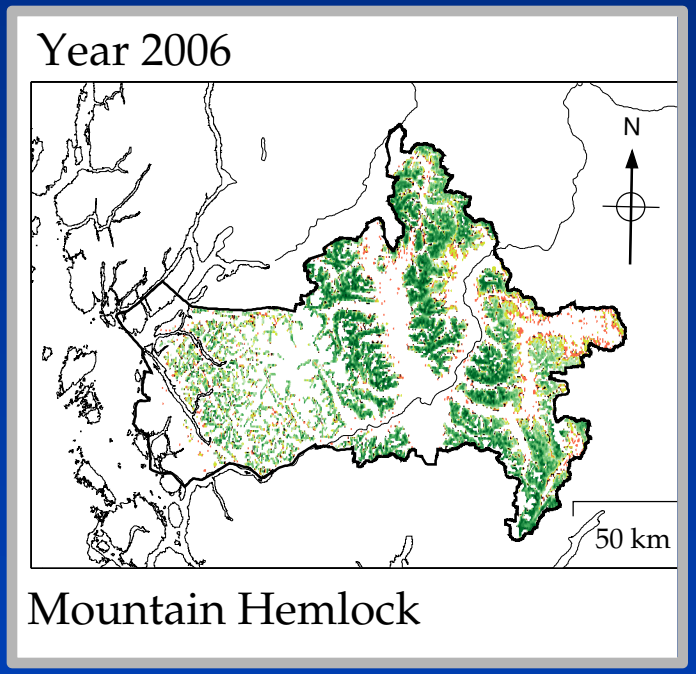
LPJ-Guess and subalpine fir



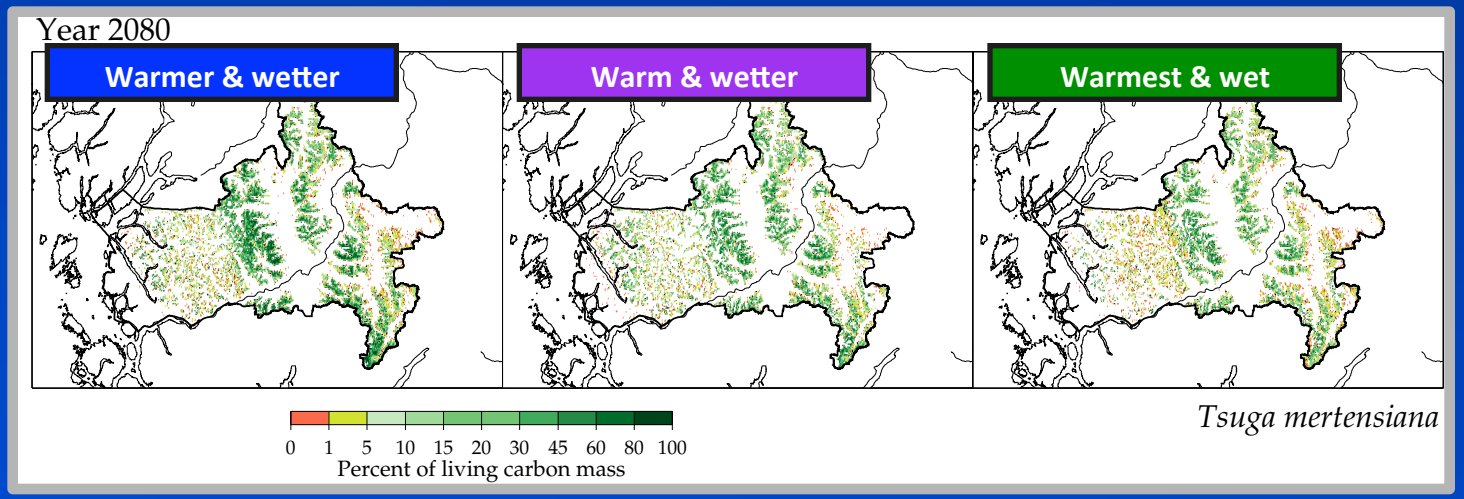
- reduced in valley bottoms
- moves upslope



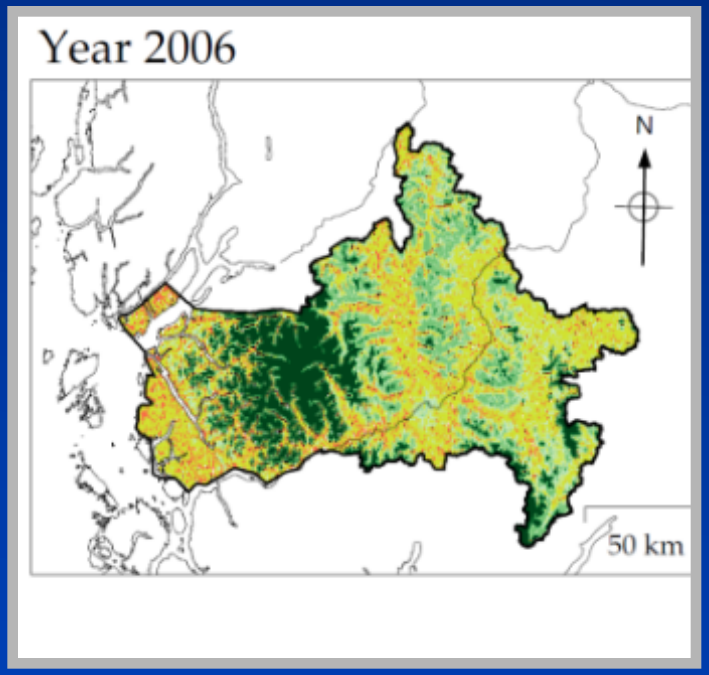
LPJ-Guess and mountain hemlock



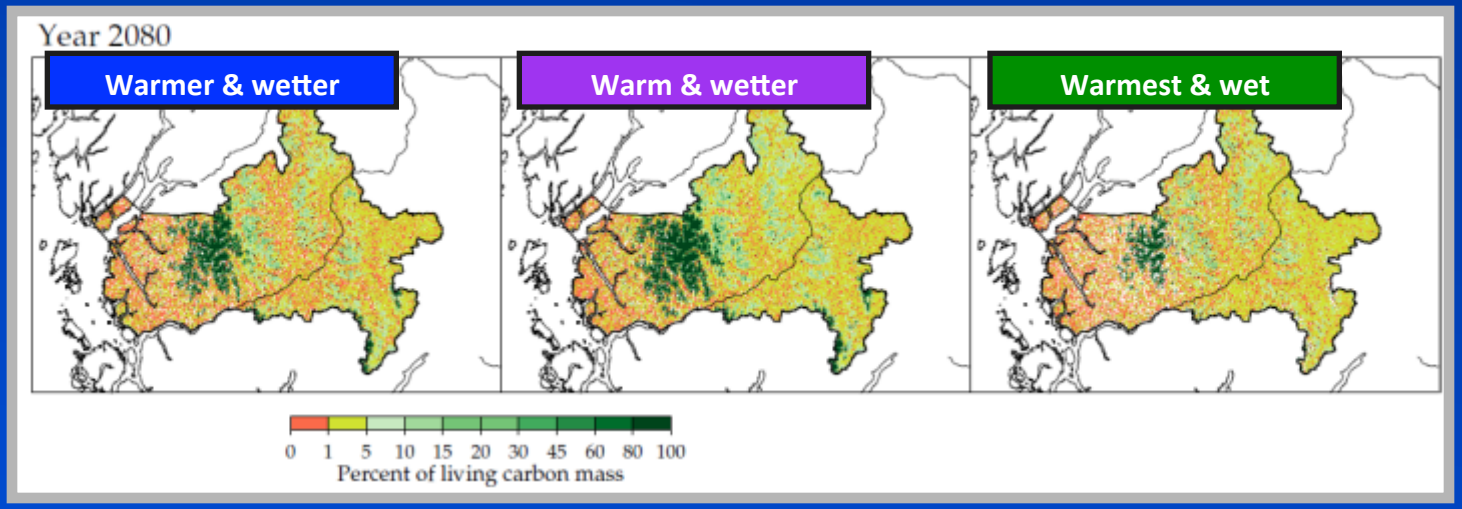
- reduced at middle and high elevations



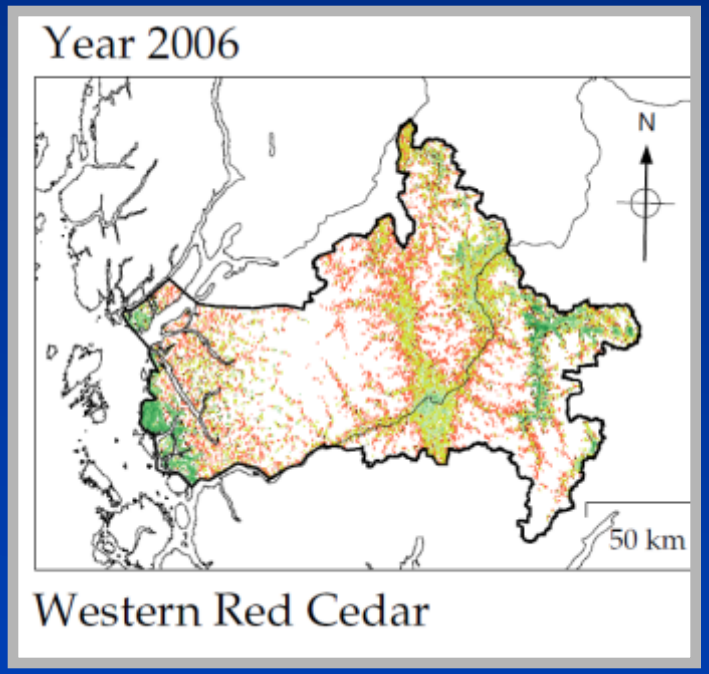
LPJ-Guess and grasses



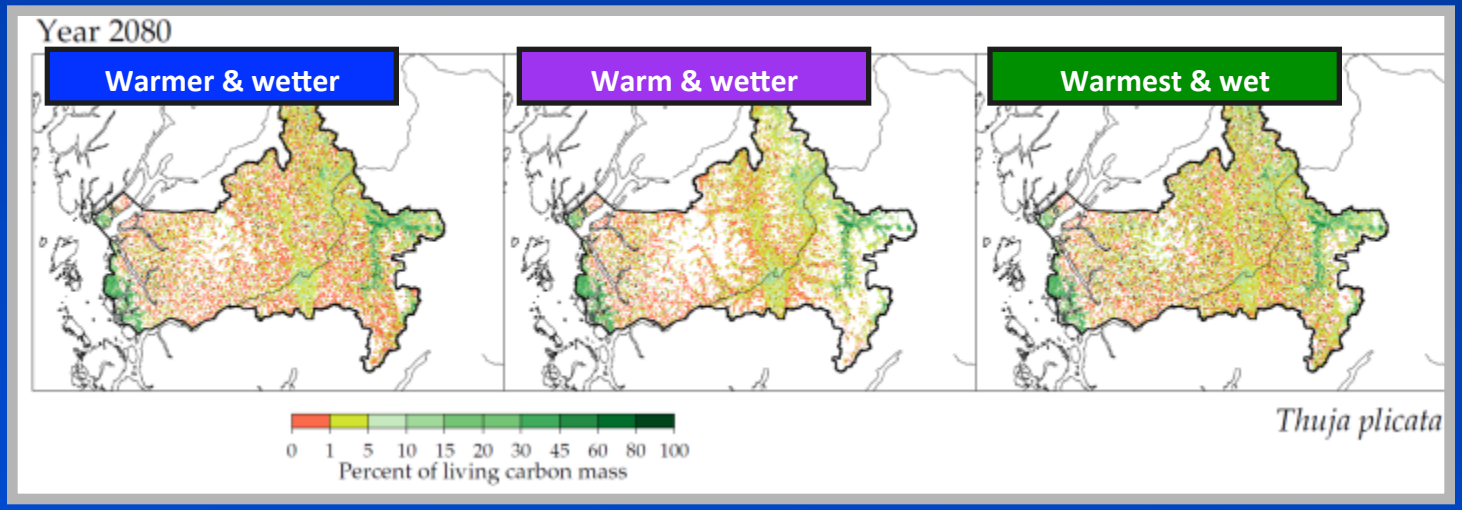
- losses at high elevation to shifting trees
- small losses at low elevation to increased trees



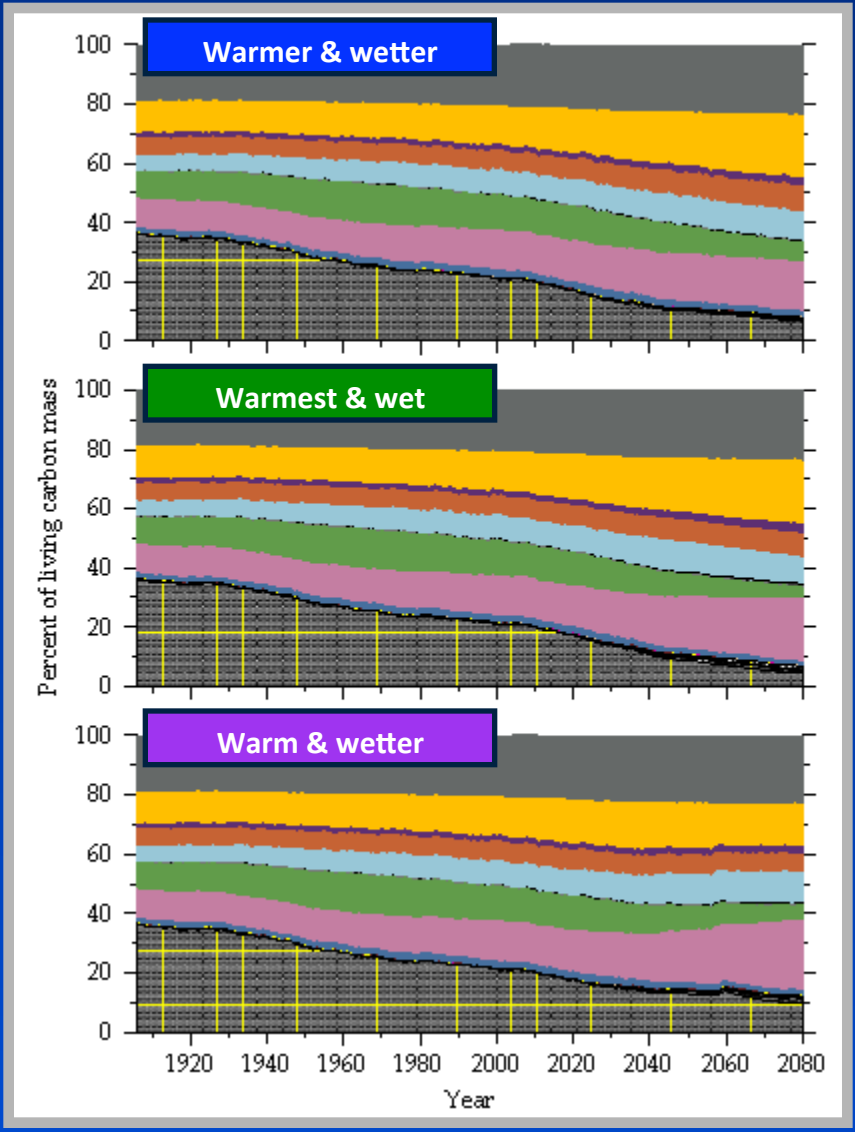
LPJ-Guess and western redcedar



- slight expansion over time
- remains prevalent on coast



LPJ-Guess and Species Shifts across Study Area



western hemlock

Pacific silver fir

western redcedar

Sitka spruce

Engelmann spruce

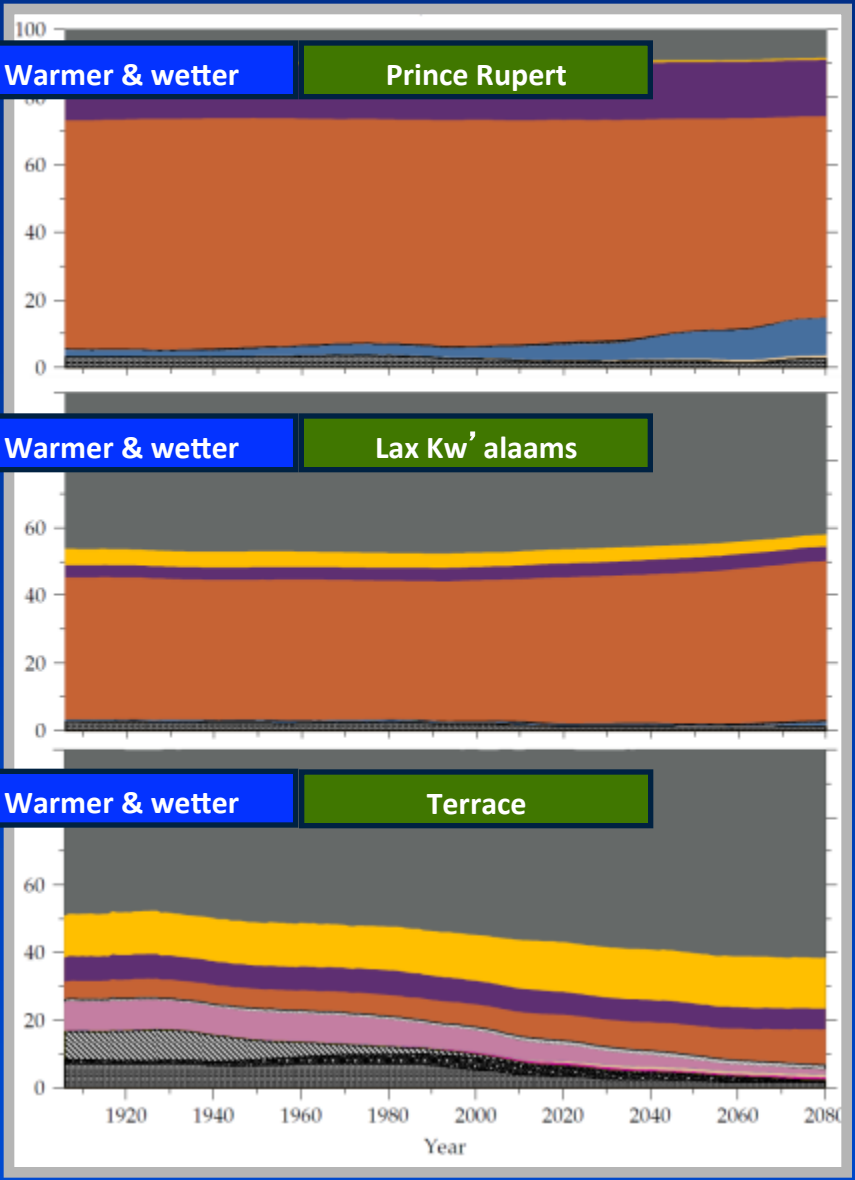
mountain hemlock

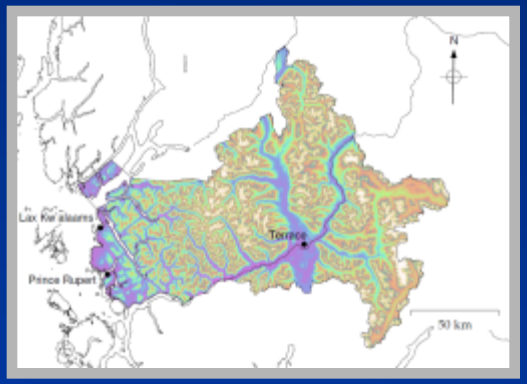
subalpine fir

yellow cedar

grasses

LPJ-Guess and Shifts around Communities





western hemlock

Pacific silver fir

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Sitka spruce

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black cottonwood

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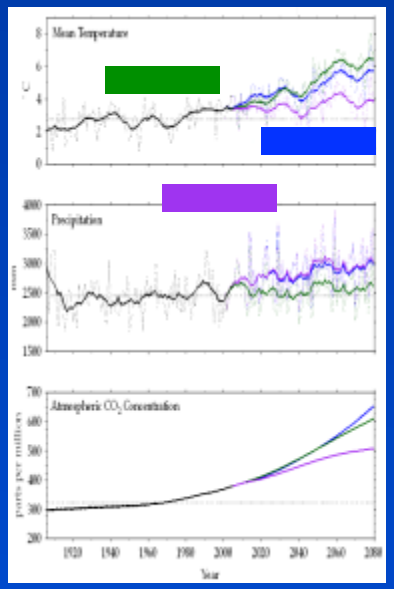
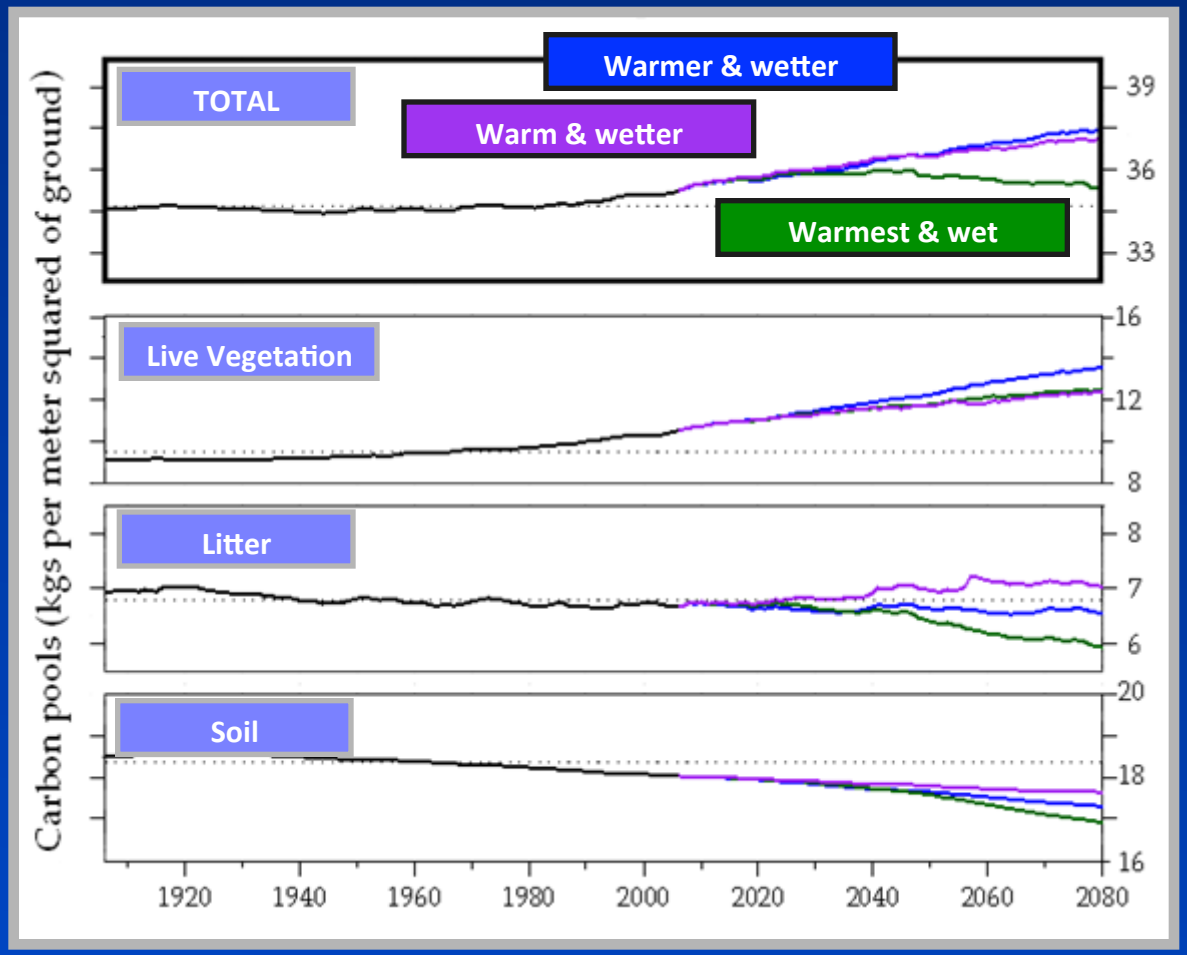
grasses

LPJ-Guess and Carbon

smoothed
average
values
over entire
region;
no harvest





LPJ-Guess and Carbon

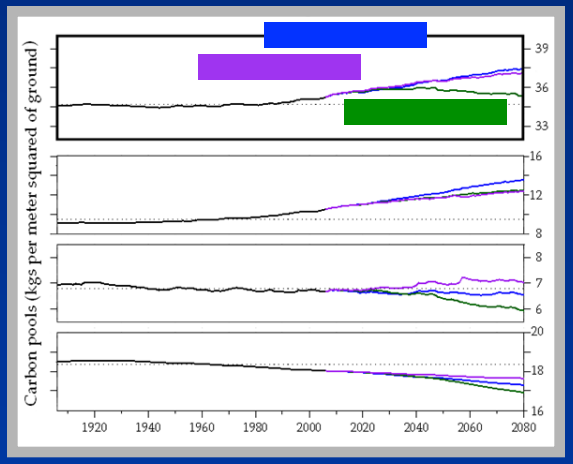
- future increase in live C stocks from CO_2 fertilization and warmer growing season

- Carbon sequestration could become a management option

- faster decomposition rates reduce soil and litter pools

- interplay between faster growth/litter and faster decomposition

- total C increases until about 2040, Possibly declining after that in “warmest wet” scenario



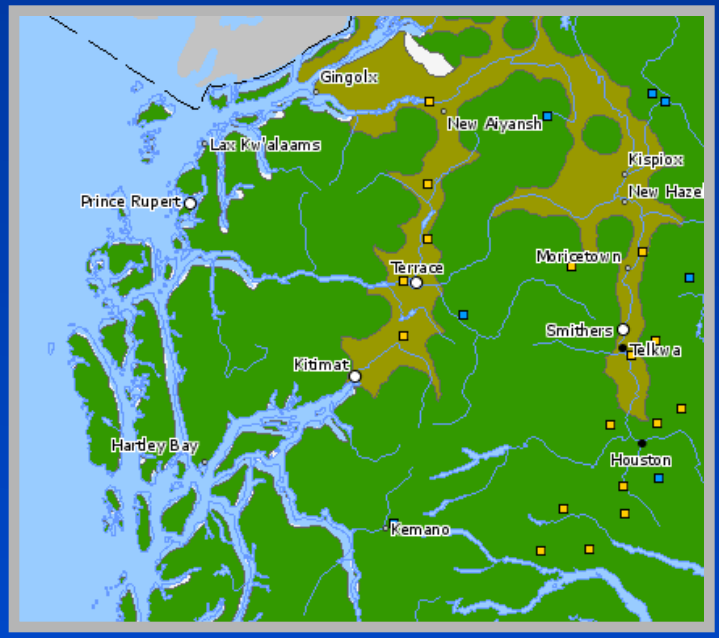
What about Fire?

- fire is infrequent in much of the study area, and remains that way under all 3 climate scenarios

- most fires caused by people

- regionally, future fire conditions will be similar to (unsuppressed) early 1900s levels

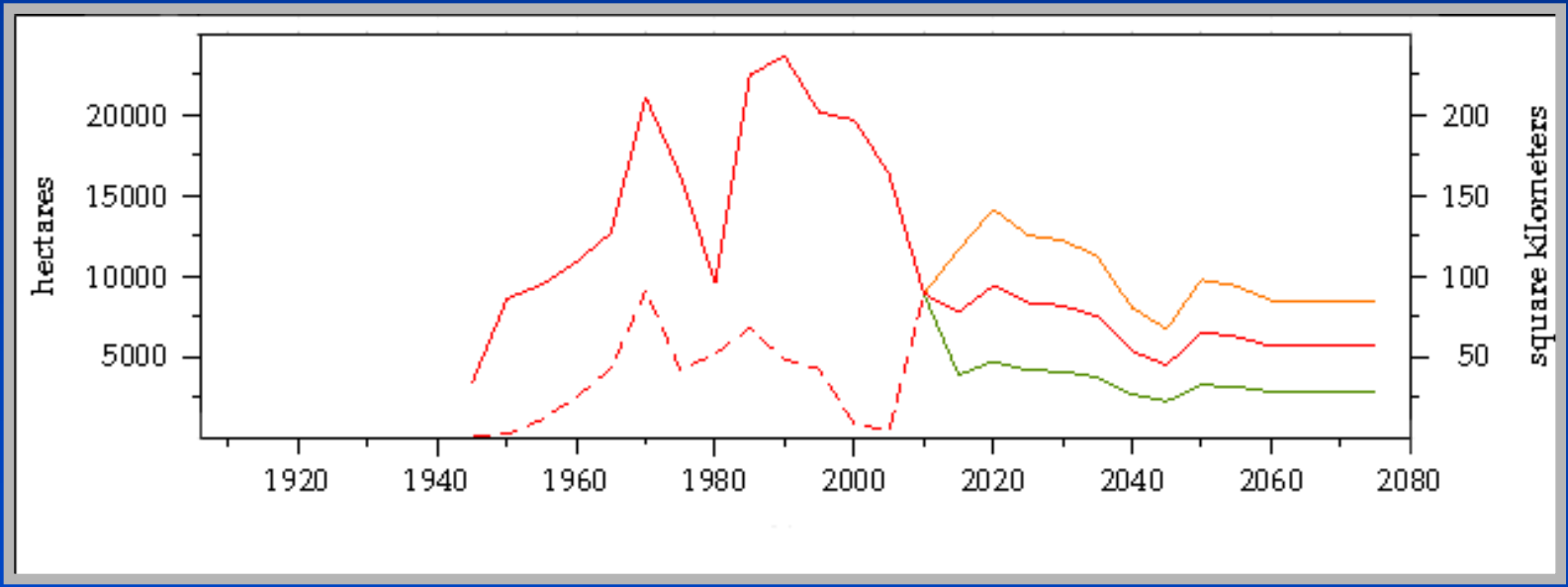
- increased fire risk for ~750 km^2 eastern side of study area



What about Harvesting?

- some simulations include historic and estimated historic harvest in TFL1

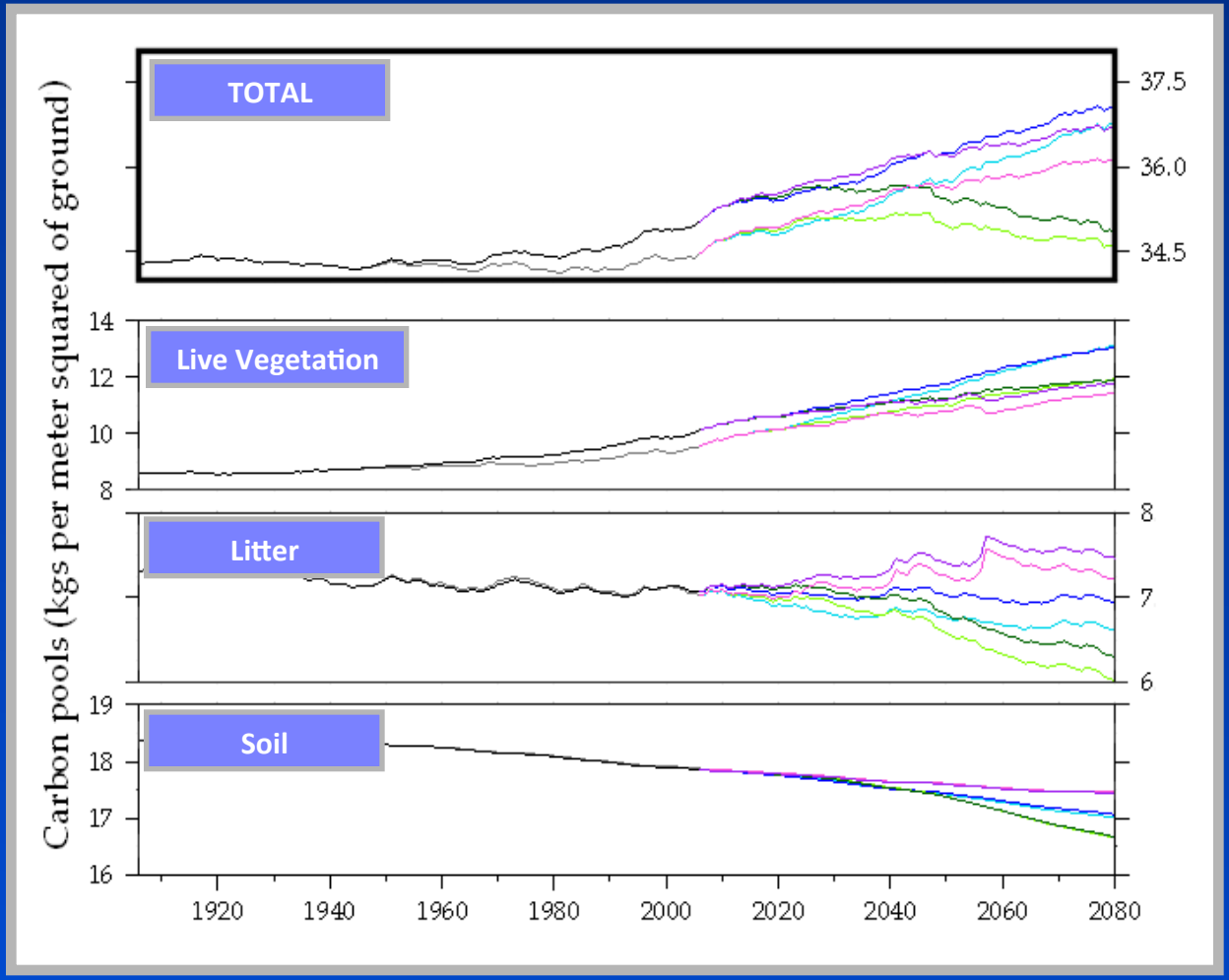
- 3 scenarios… **50%, 100%, 150%** of 2010 AAC, converted to hectares



- Annual harvest in figure is reported every 5 years

What about Harvesting?

Comparison 1: Across Climate Scenarios



No Harvest

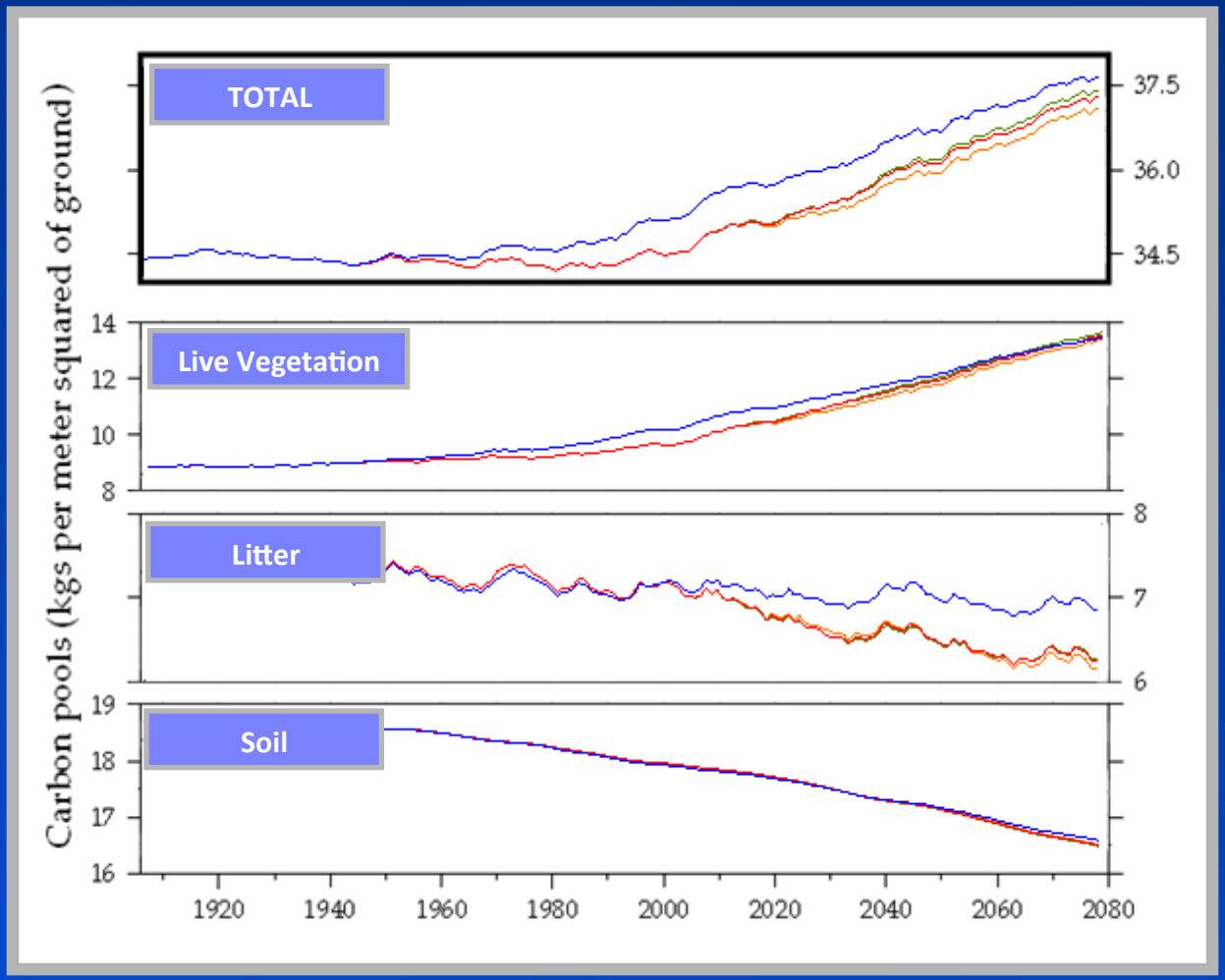
- Warmer & wetter
- Warm & wetter
- Warmest & wet

100% AAC Harvest

- Warmer & wetter
- Warm & wetter
- Warmest & wet

What about Harvesting?

Comparison 2: Across AAC Scenarios



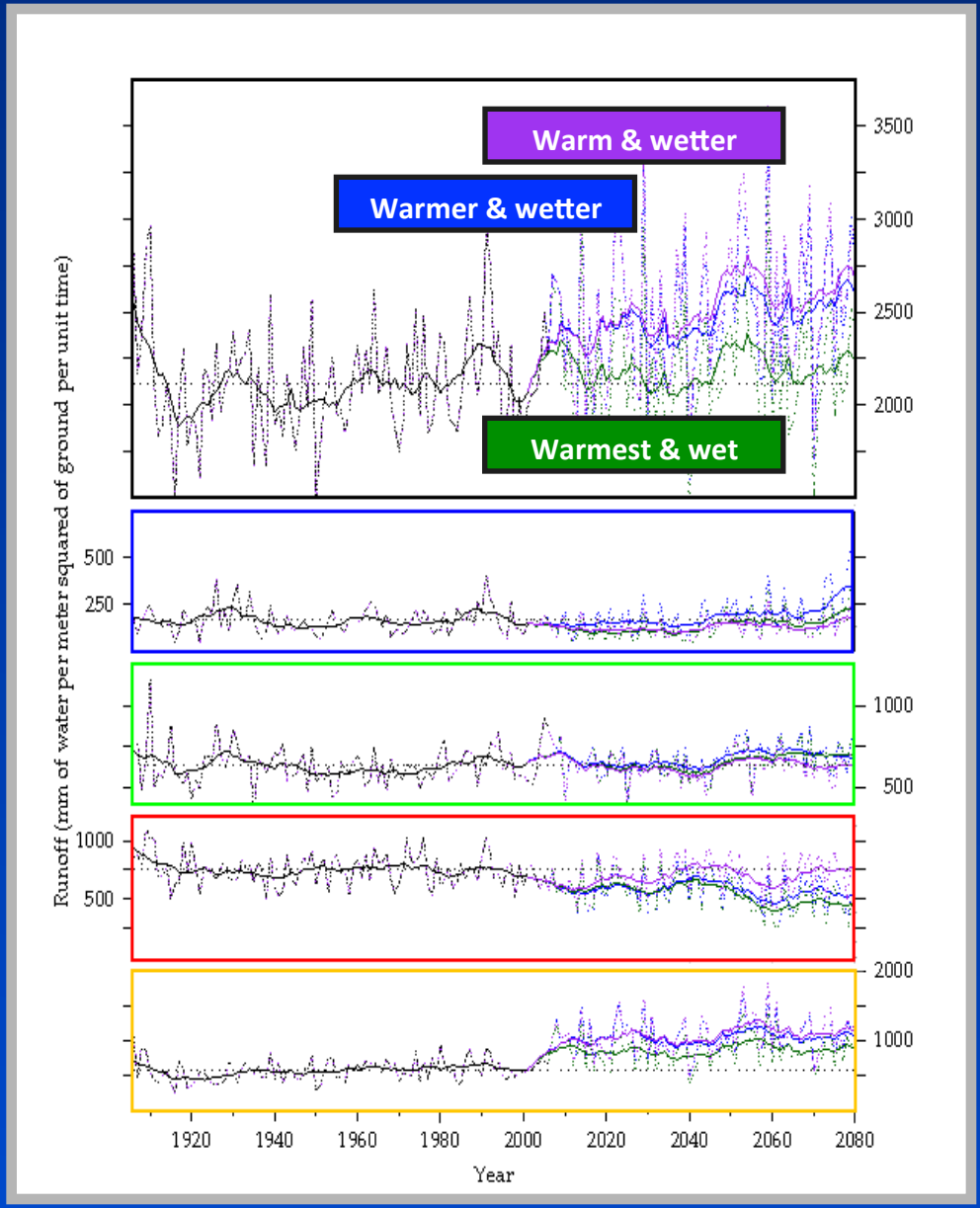
Warmer & wetter

- No Harvest
- 150% AAC
- 100% AAC
- 50% AAC

What about Harvest & Runoff?

Harvest is <1% annually over 32,000 km^2 study area

At this scale, harvesting has a very small effect on runoff



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What Can We Take Away?

1. Change in runoff timing: 70 years from now…
   -20% summer, +100% autumn
2. Lots of weather variation year-to-year, but consistent warming trend; usually wetter

3. Landscape is greener: grass replaced by trees
4. Alpine tree species replaced by mid-slope species
5. Climate change scenarios have much bigger impact on vegetation or carbon than harvesting or fire

6. Regional results (runoff) don't scale down to the site level in simplified LPJ-Guess hydrology
7. Uncertainty about reliability of scaling: **monthly** and **regional** temperature and runoff don't automatically predict **daily** and **local** temperature and rainfall patterns