Climate change impacts on land use suitability

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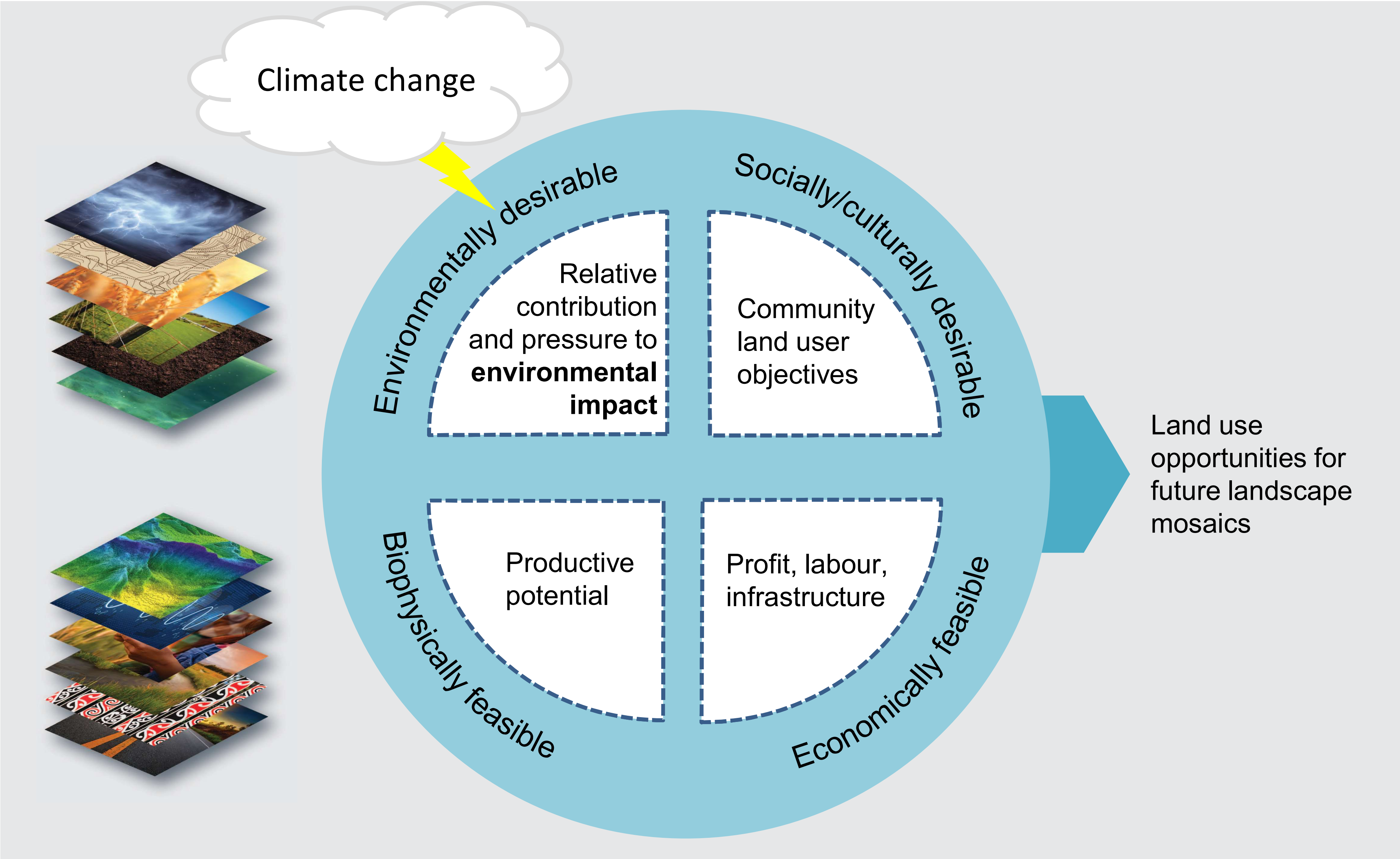
What is land use suitability?

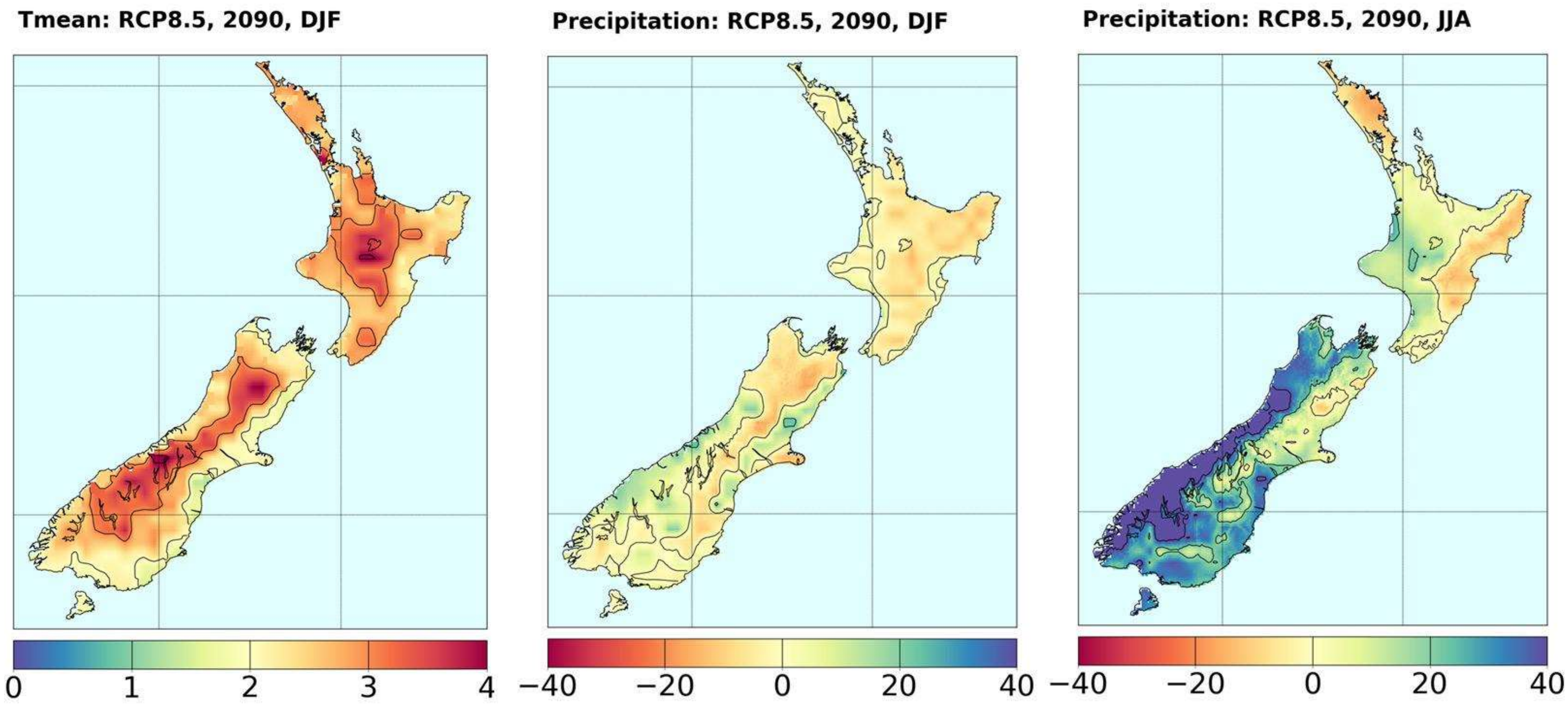


Climate Change long-term projections

Hotter everywhere

Drier in summer

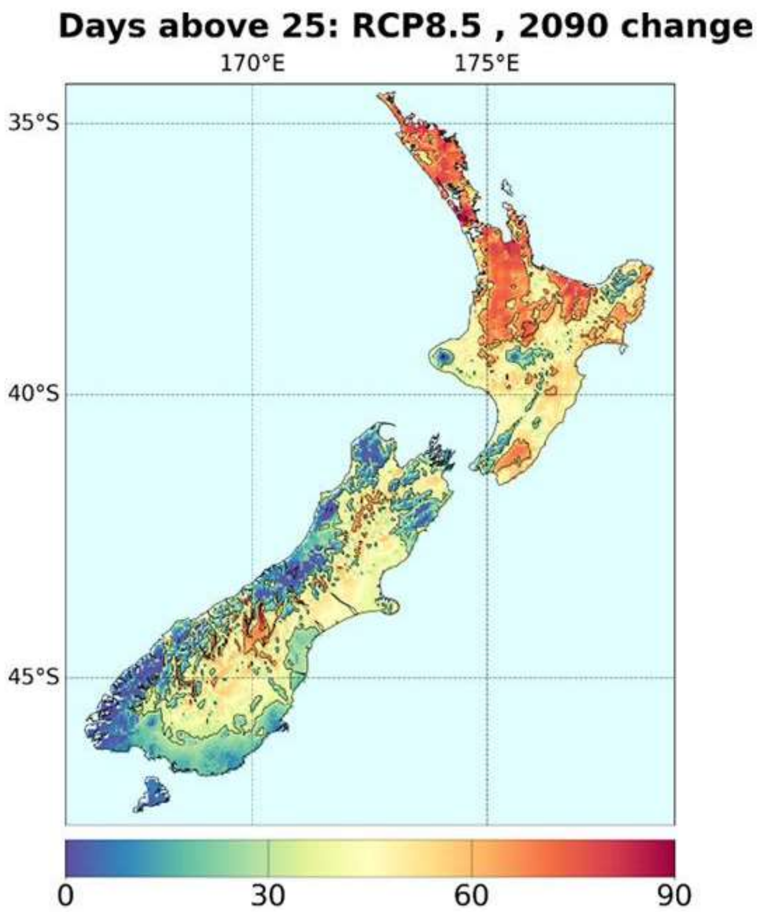
Wetter on the SW in winter



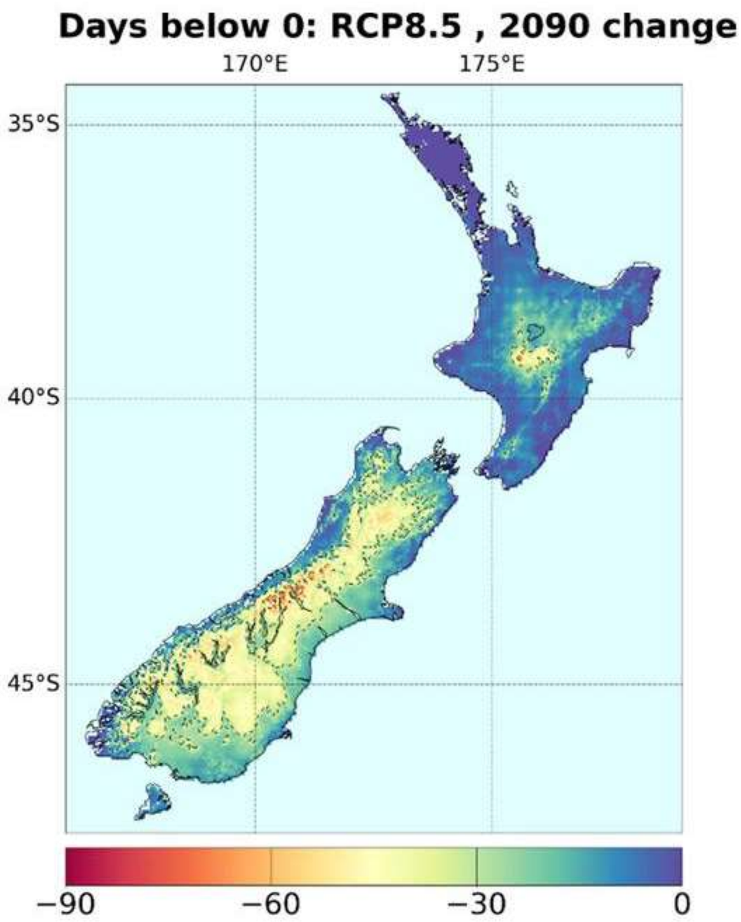
NIWA website: https://niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios

Projected changes in extremes

More hot days in summer



Less cold days



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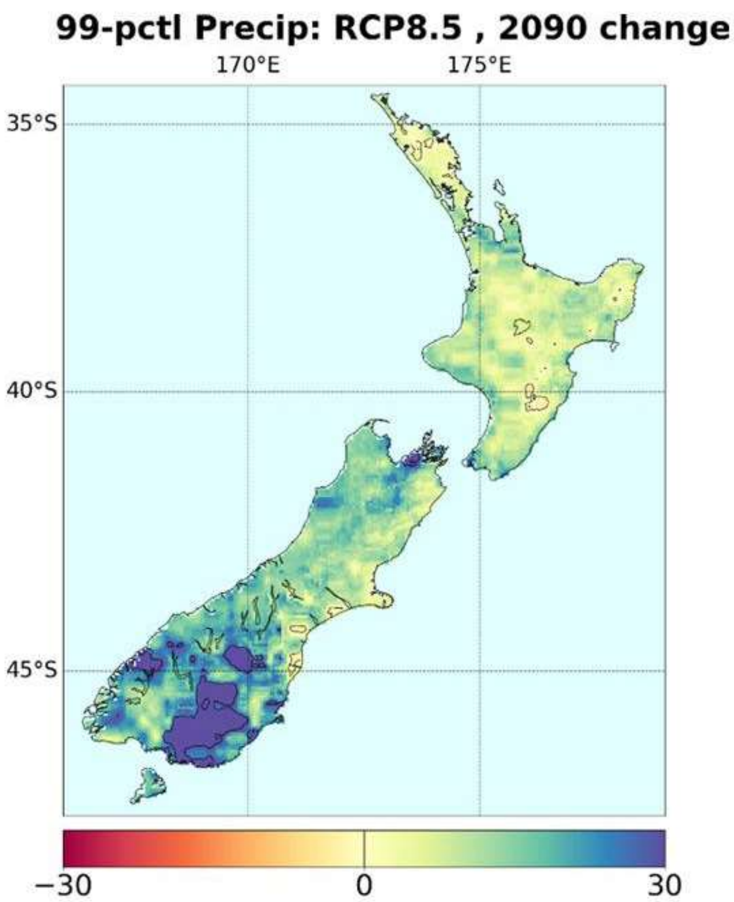
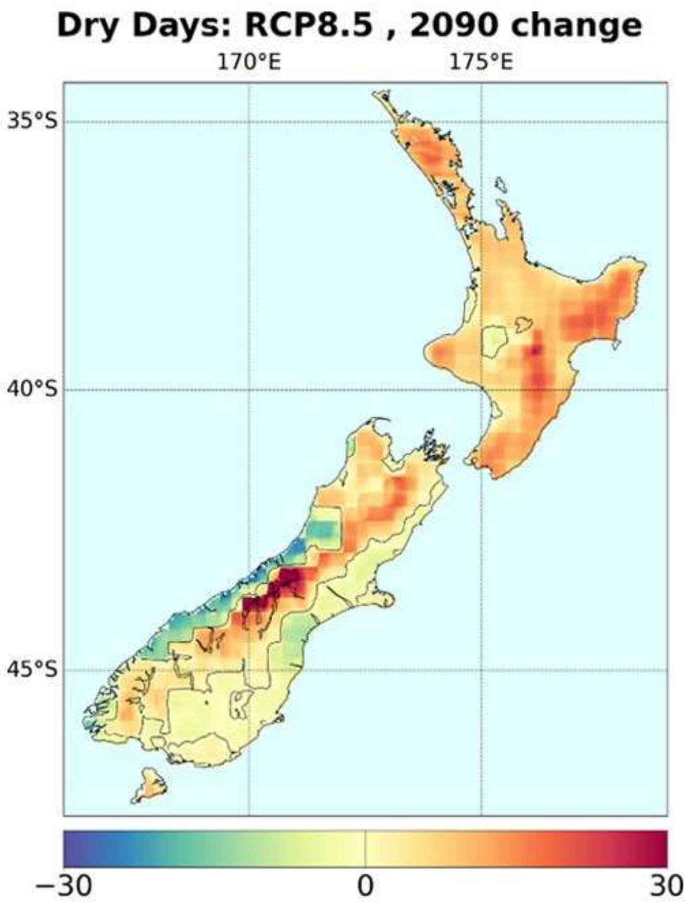
Projected changes in extremes

More intense rainfall in the South



Time spent in drought in eastern and northern NZ is projected to double or triple by 2040



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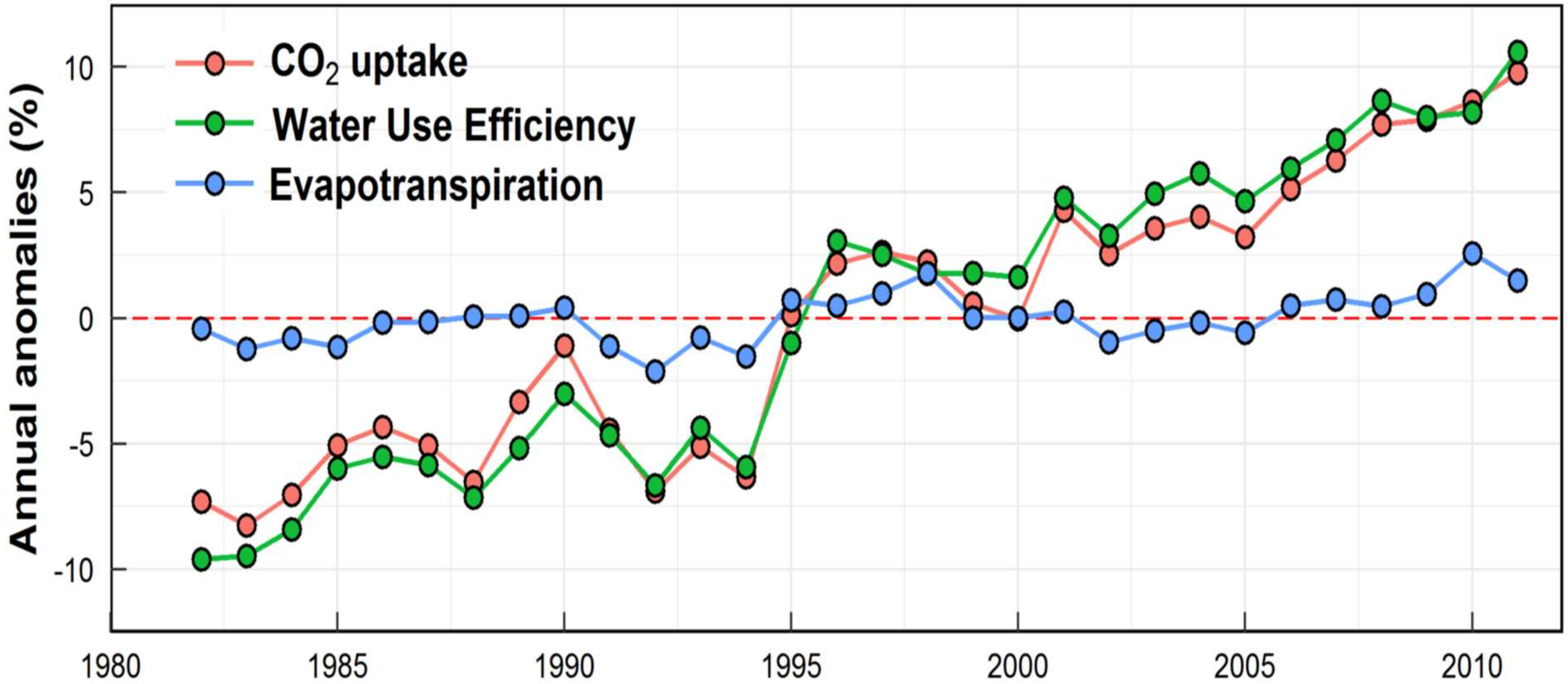
Rising CO_2 makes plant more water-efficient

Global production from land plants up 15-20% with 0.7°C temperature change



theconversation.com/rising-carbon-dioxide-is-making-the-worlds-plants-more-water-wise

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Objectives

- 2-year project (2017-2019)
- 2 goals

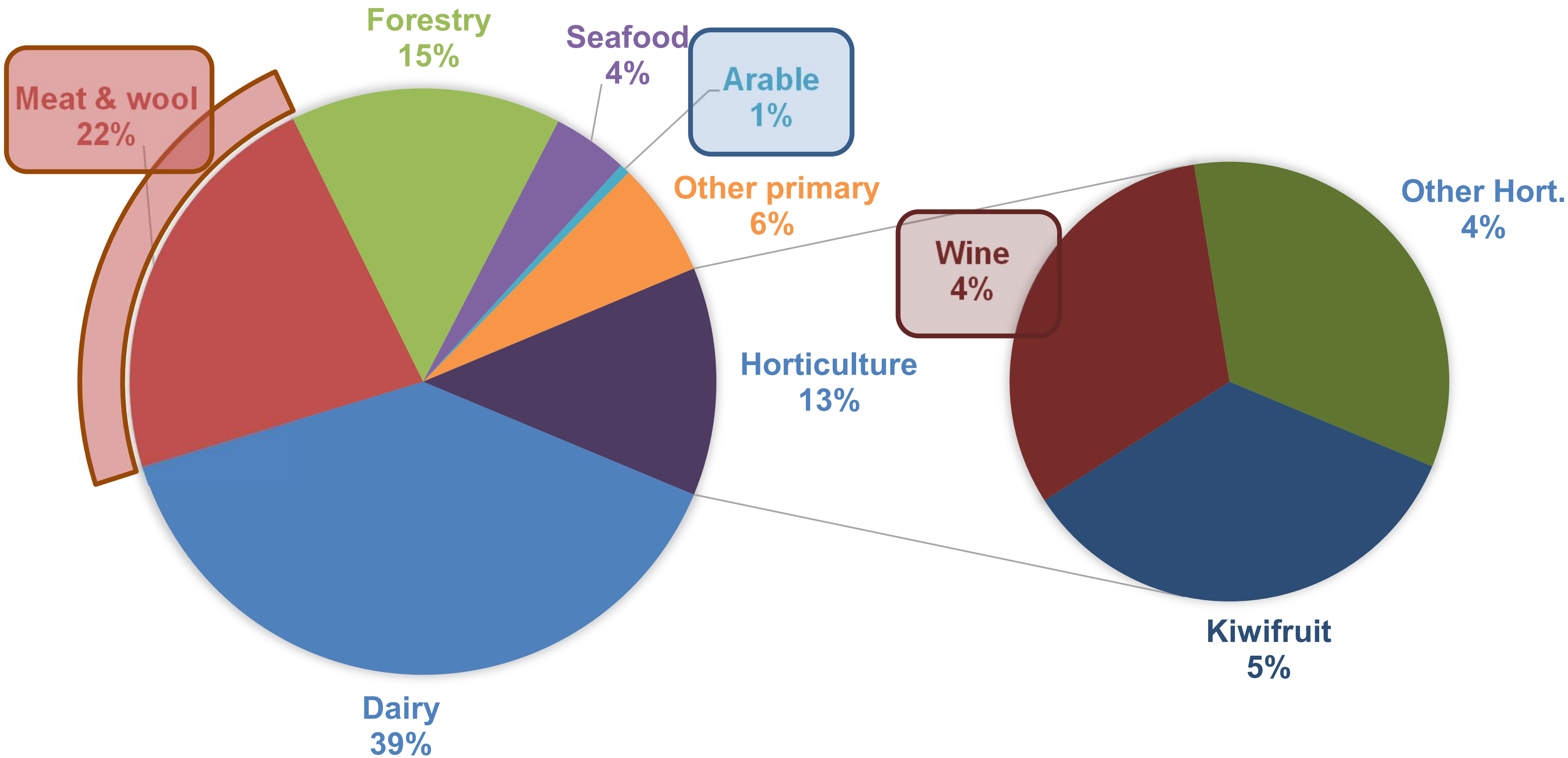
Explore future climate change impacts (long-term shifts and drought)

Identify climate attributes influencing productive potential and environmental impacts for land use suitability

$43 Billion in Primary Exports

Where did we focus?

2018 Data from SOPI



Focus: sheep/beef pasture, maize/wheat rotation, wine grapes

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Method and scale of analysis

Model	Scale	Complexity /tier	Process	CO_2 fert.	Management information
APSIM – pasture /arable	Point (Hawkes Bay, Waikato, Southland)	High Tier 3	✓	✓	✓
Biome-BGC – pasture	Regional (Hawkes Bay)	Intermediate Tier 2	✓	✓	Minimal
WatYield – pasture/arable/hort	Point + Regional (Hawkes Bay)	Intermediate Tier 2	✓	✗	Minimal
Climate Indices	National	Low Tier 1	✗	✗	✗

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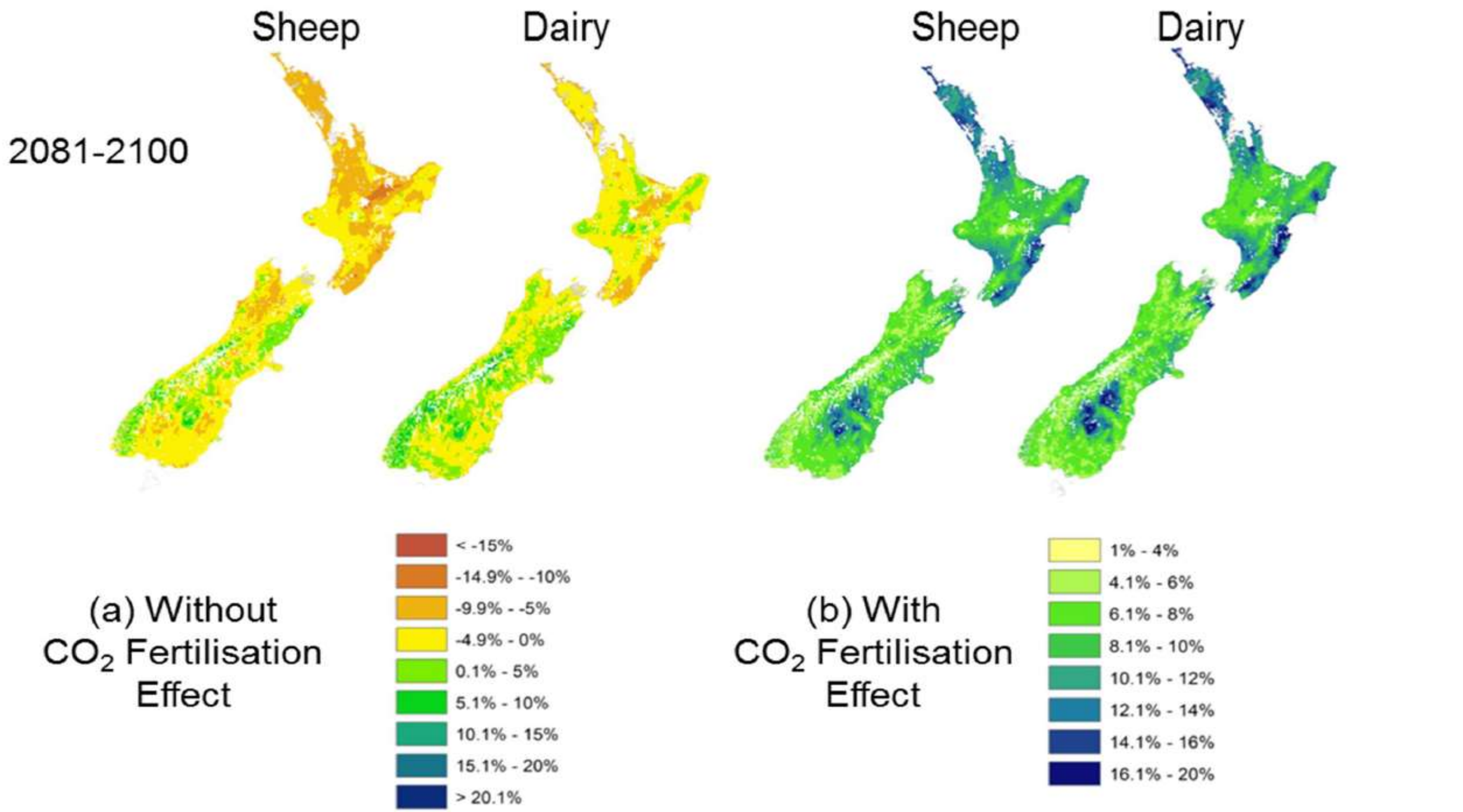
Exploring future climate change impacts

- On productive potential:
  - Pasture production (*APSIM/BiomeBGC*) and animal heat stress (*climate index*)
  - Maize/wheat production (*APSIM*)
  - Wine grape phenology (*climate index*)

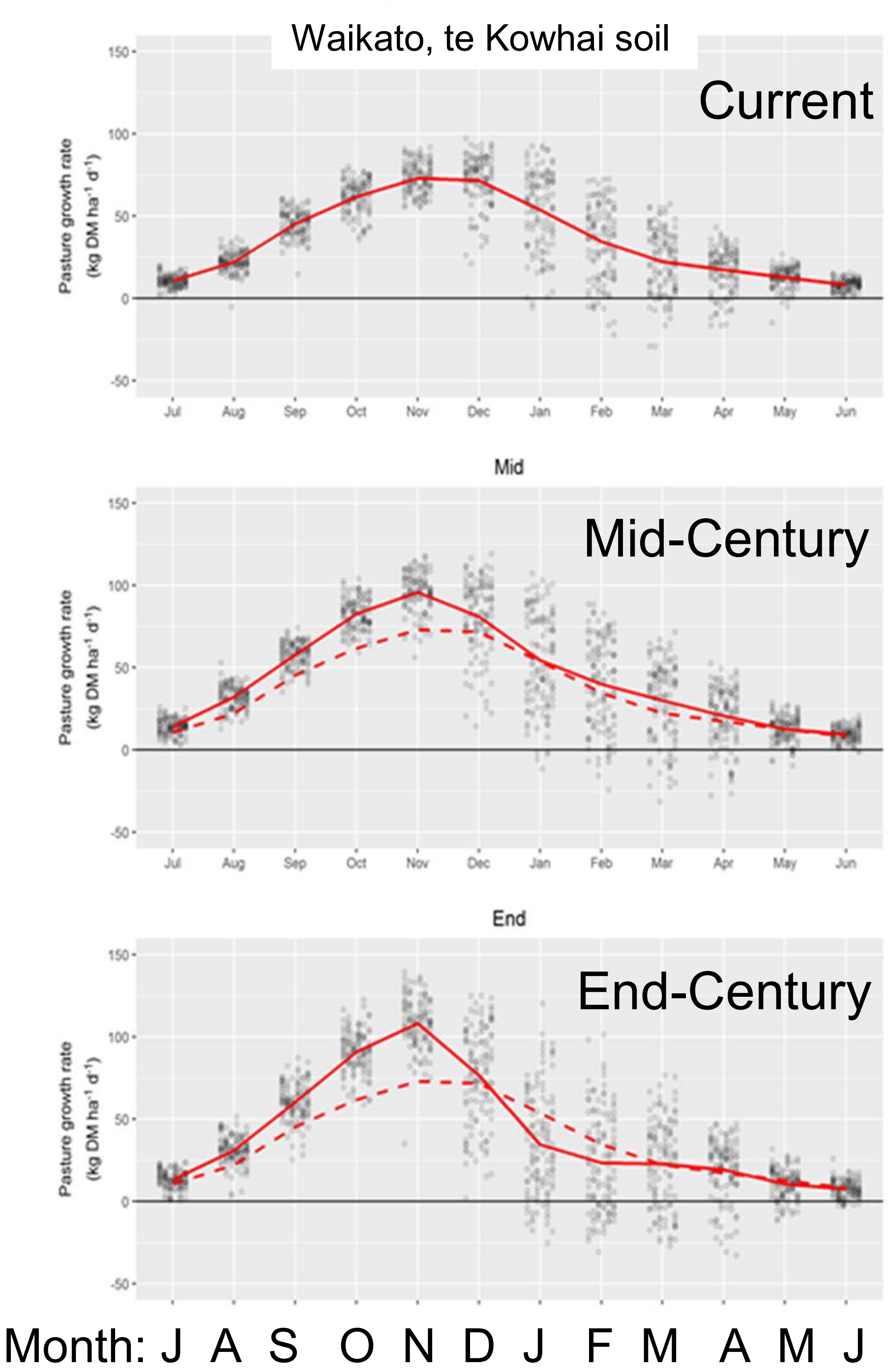
- On environmental impacts
  - Nitrate leaching from pasture, maize (*APSIM*)

- On water demand (*biomeBGC, Watyield*)

Impact of climate change on sheep/beef and dairy



Rutledge et al (2017)



Pasture yield

- Shift in monthly pasture growth rates:
  - Higher spring peak
  - Lower in summer
- Variability in soils and regions and climate models
- Influences feed stock management

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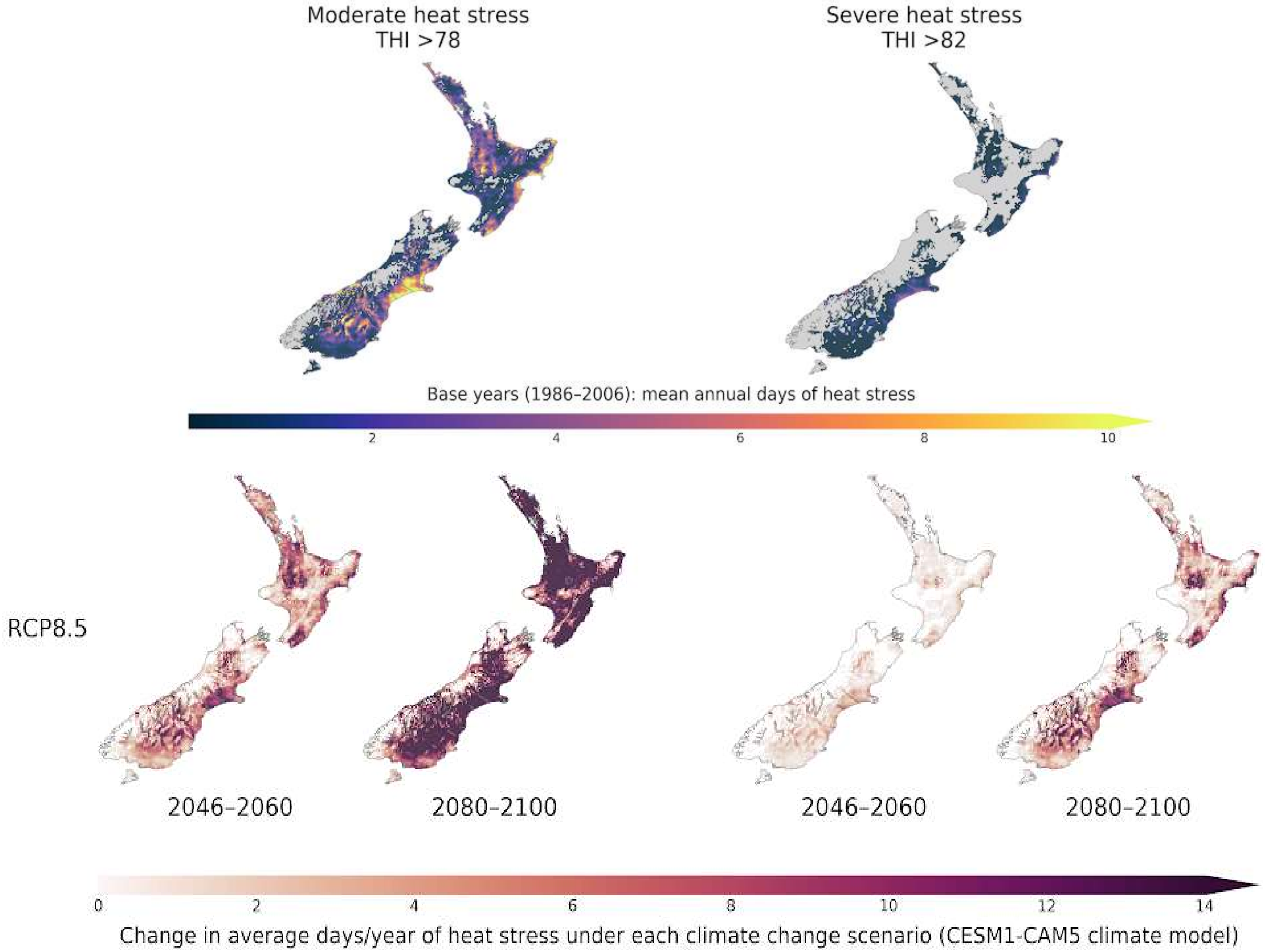
Change in animal heat stress risk



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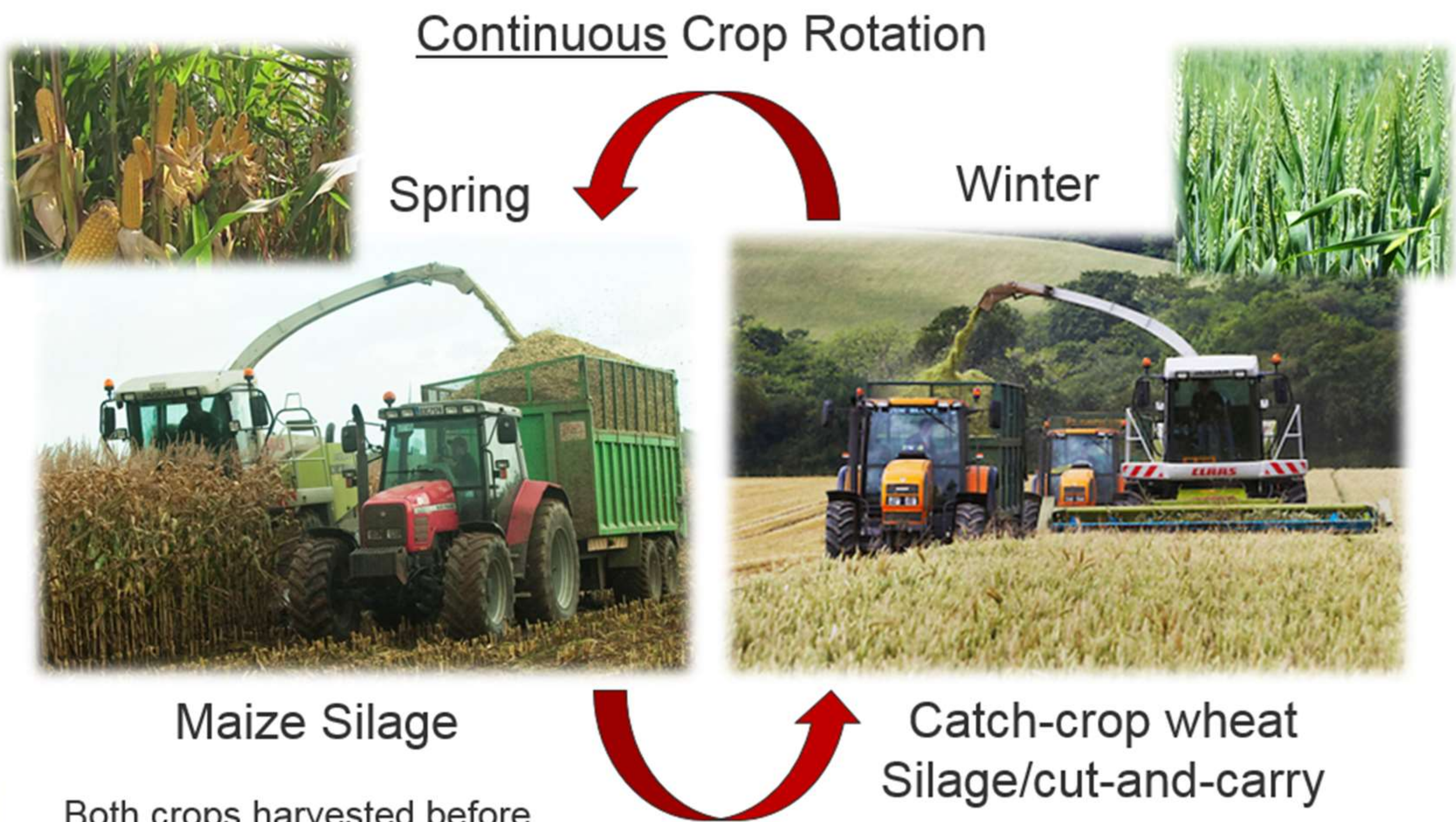
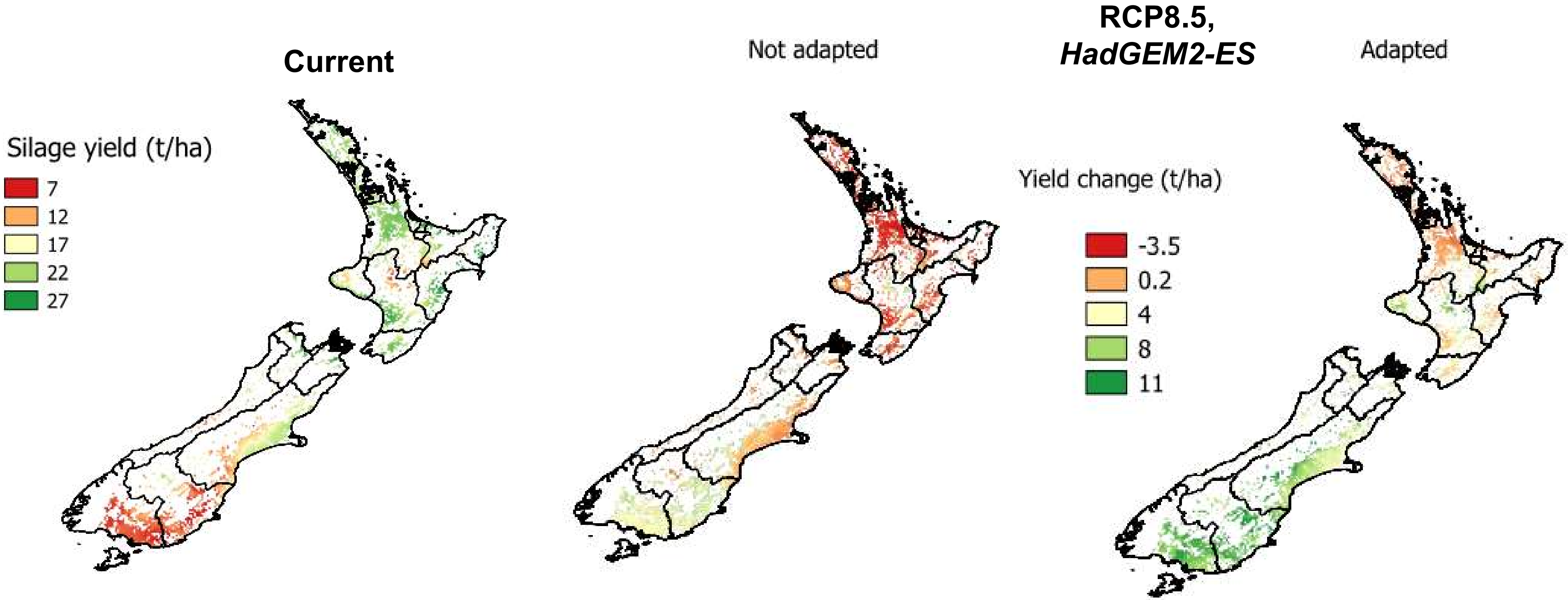
Cropping systems

Rotation with spring/summer (maize) and autumn/winter (catch-crop wheat) crops



Both crops harvested before grain maturity

CCII: impact of climate change on irrigated maize production and adaptation



Higher yields in South Island, lower in North Island. Counter effect with adapting genotype and sowing date

Rutledge et al. (2017). CCII synthesis report.

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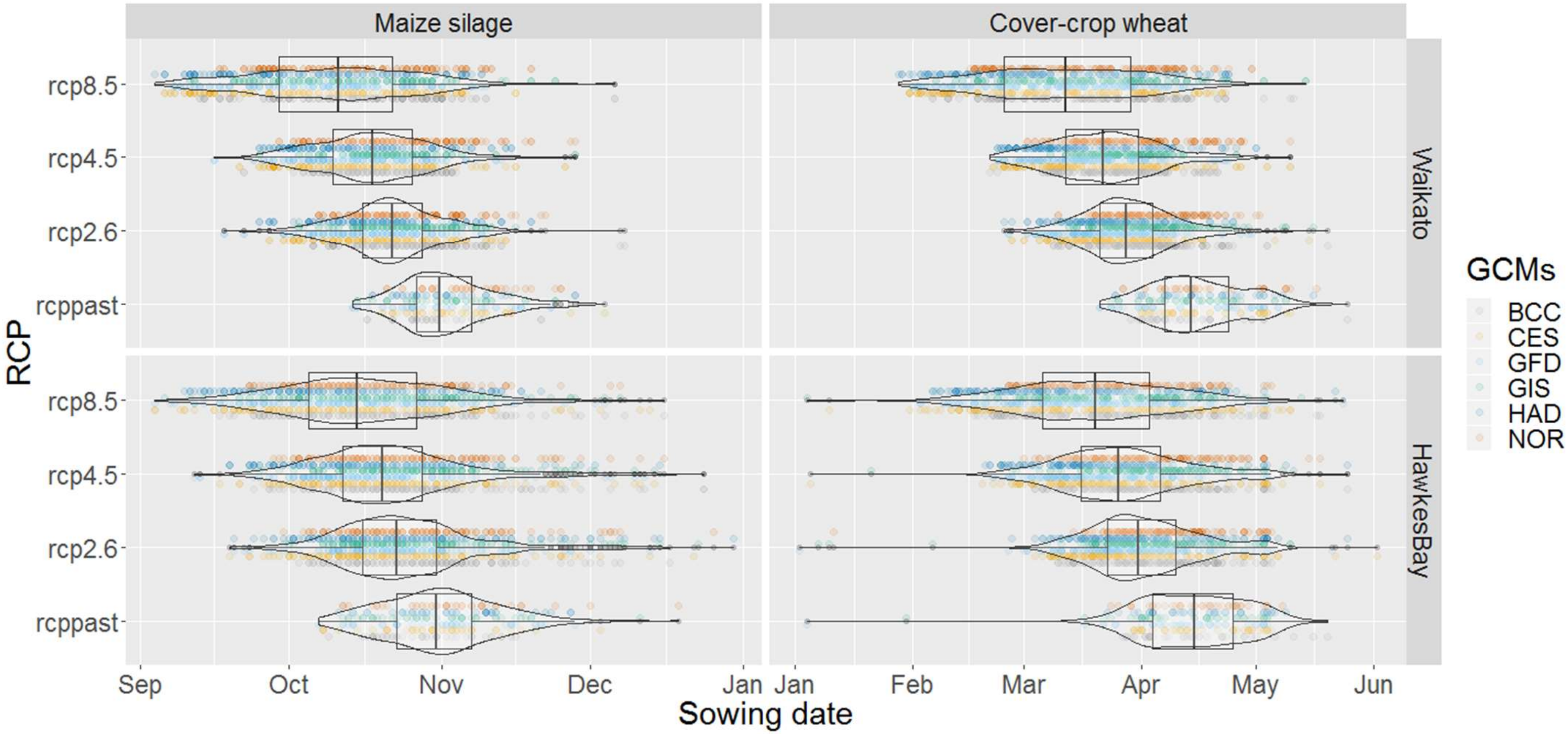
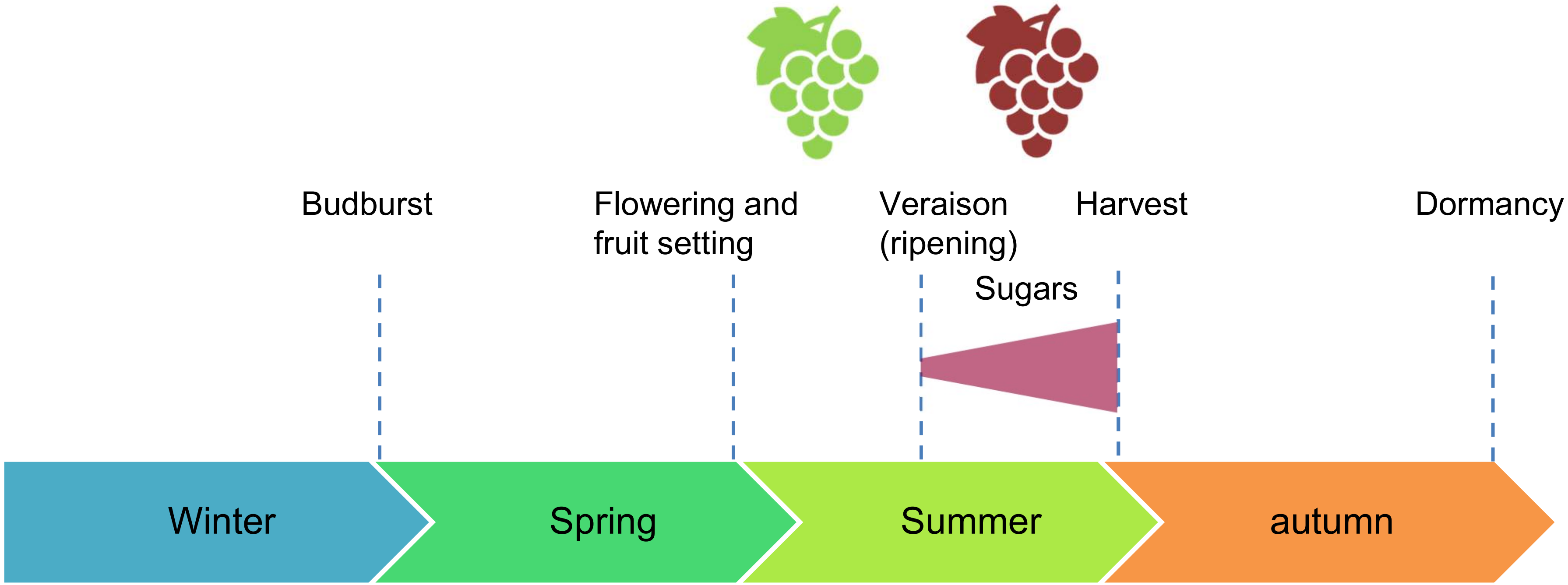
Cropping systems (end of century)



Early sowing of maize -> early sowing of catch crop wheat -> longer growth period for wheat -> higher yields

The growth stages of wine grapes



Thermal accumulation affects timing of growth stages

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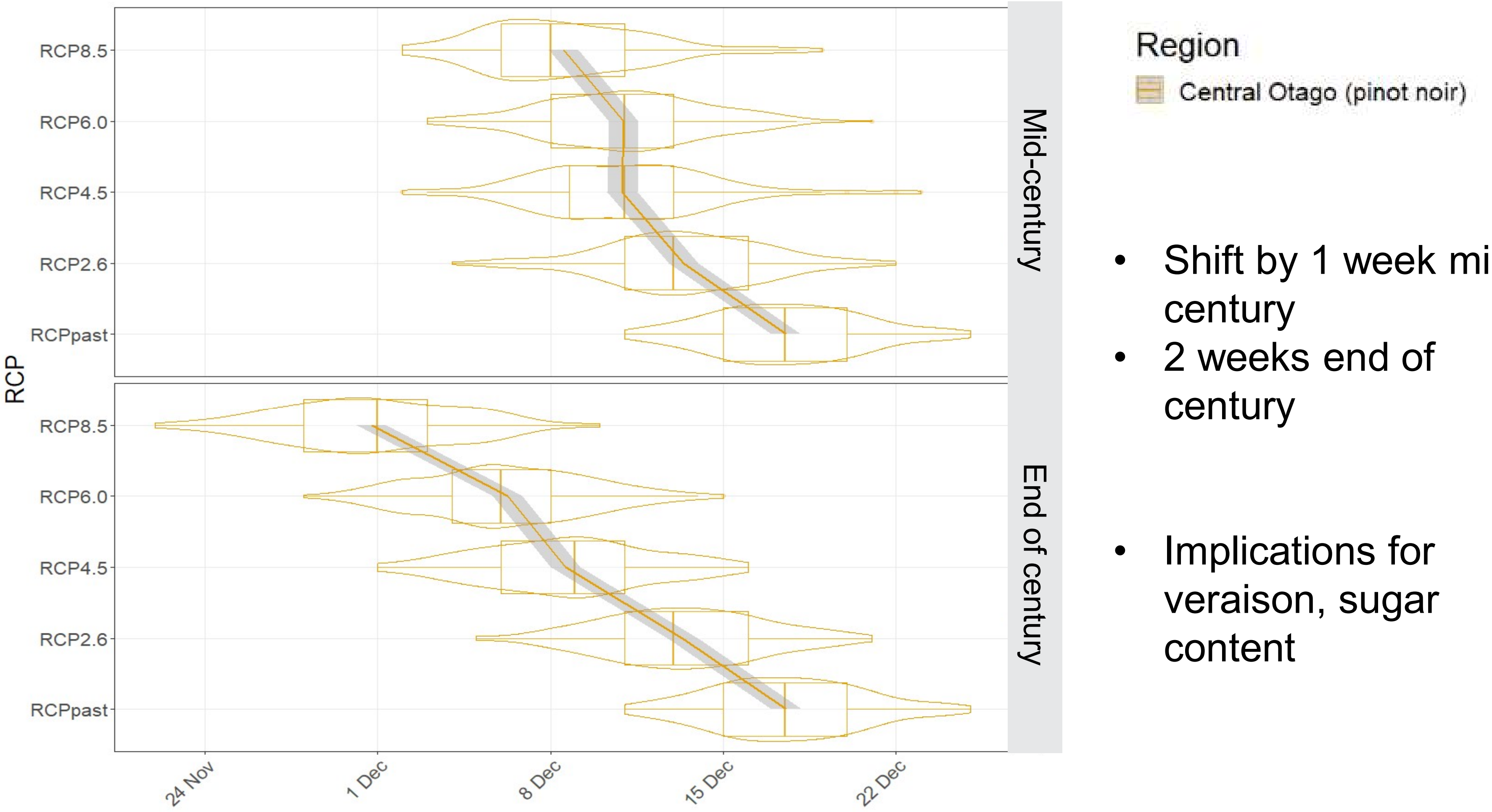
Shift in flowering dates



- Shift by 1 week mid-century
- 2 weeks end of century

- Implications for veraison, sugar content

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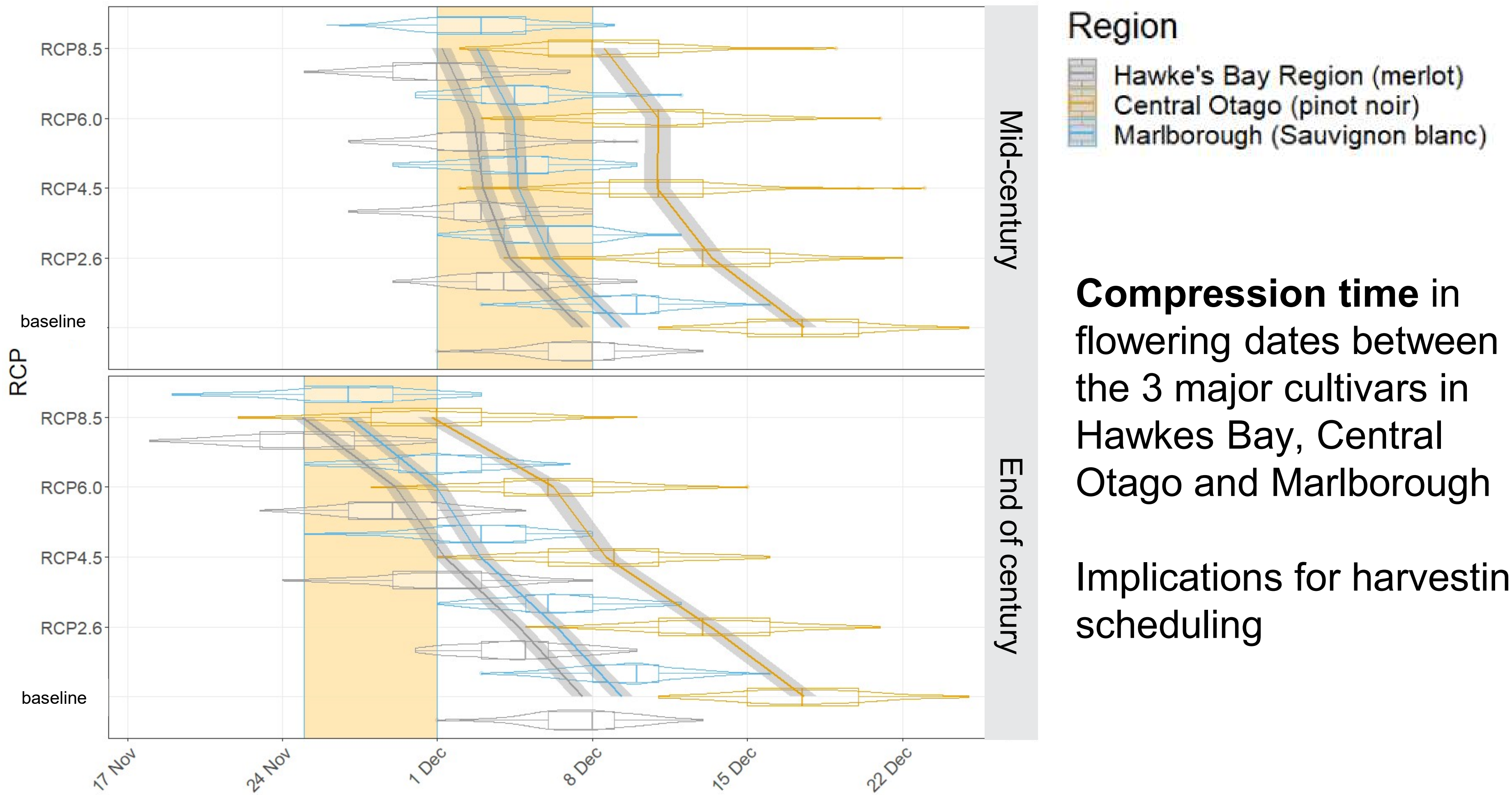
Shift in flowering dates



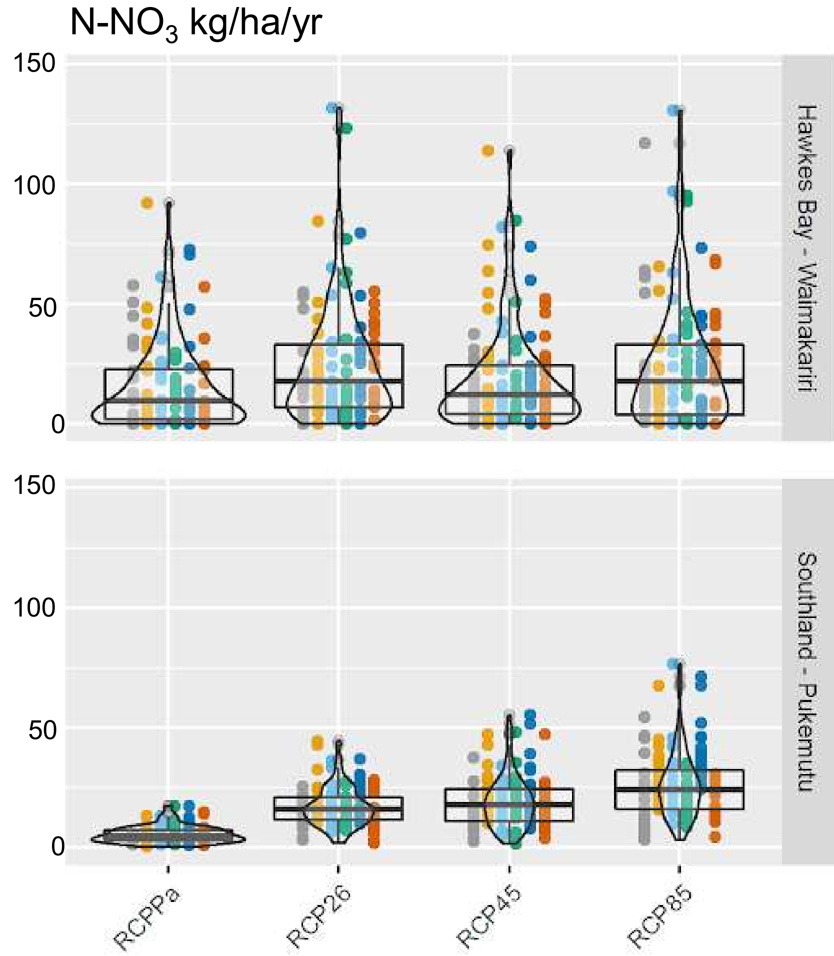
Compression time in flowering dates between the 3 major cultivars in Hawkes Bay, Central Otago and Marlborough

Implications for harvesting scheduling

Co-funded by Manaaki Whenua, Amber Parker Lincoln University

Nitrate leaching in pasture/maize

- N leaching tends to be higher in the 3 regions
  - More significant change in Southland
  - Strong inter-annual variability
- Lower Nleaching in soils with higher water holding capacity
- Maize/wheat: Higher N uptake by catch crop



Extract from pasture results (End of century)

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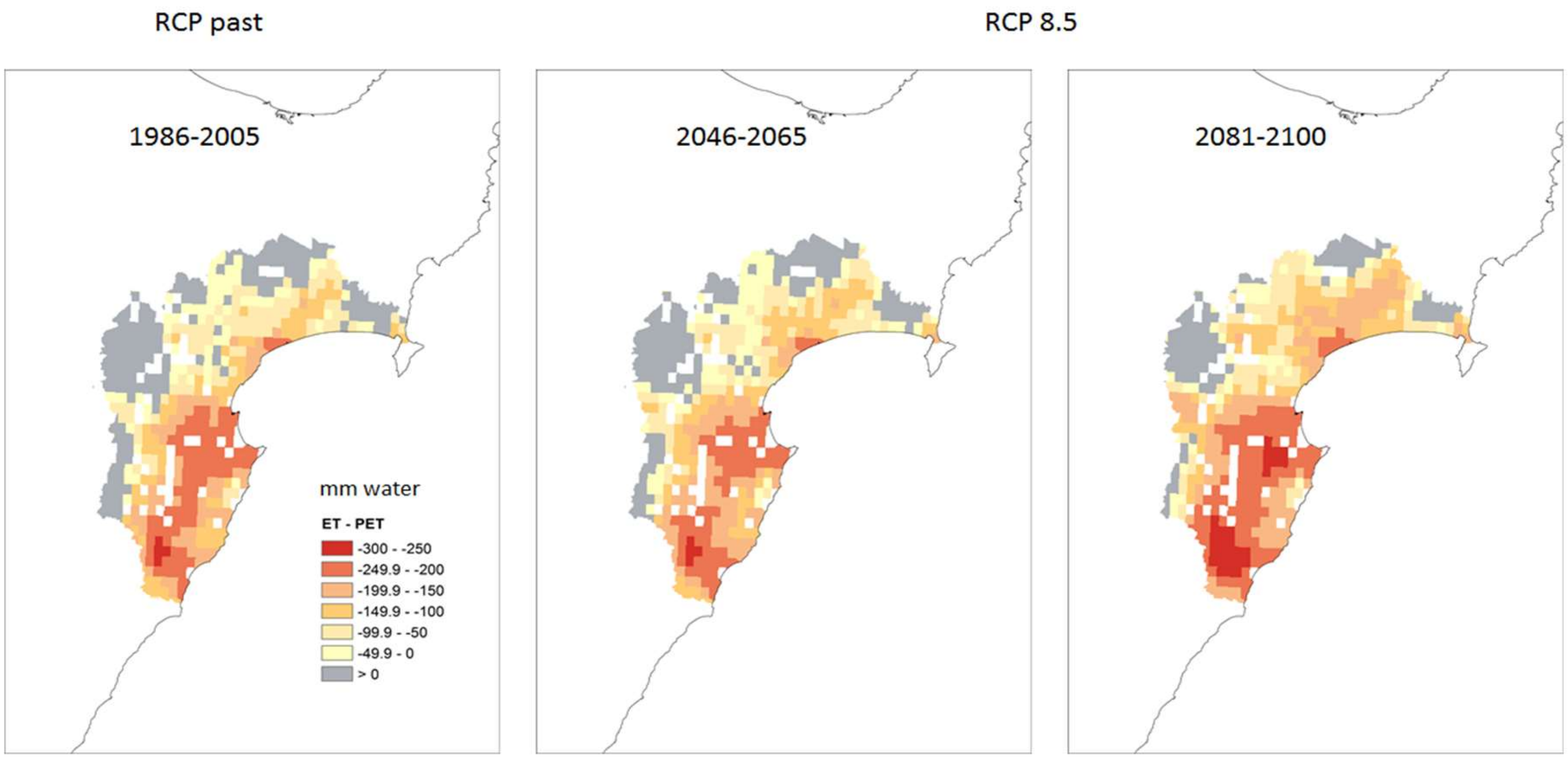
Change in water demand (summer)



- PED = potential evapotranspiration deficit
- Increase in water limitation spatially variable, implication for irrigation demand

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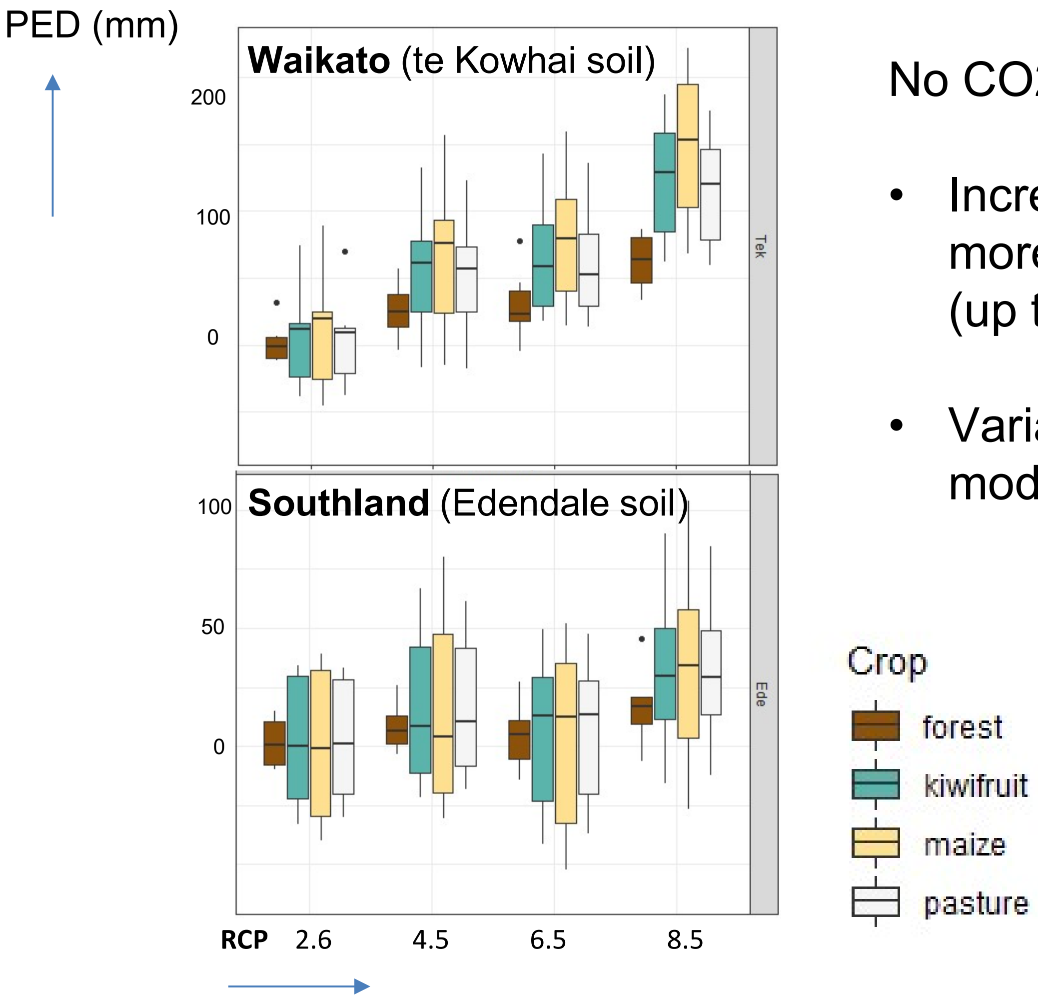
Water balance model



No CO2 fertilisation modelled:

- Increase water demand in all regions, more relative increase in the Waikato (up to 40%)
- Variability due to soils and climate models

Identify climate attributes for land use suitability

- Can we attribute complex models results to simple metrics?
  - Need to consider strong influence of soil and water

% Variance Explained (pasture production)	**APSIM**	**Biome-BGC**
Water-related indices (PED)	29.4 %	40.7 %
Soil type	26.1 %	19.8 %
Climate attributes	19.1 %	27.0 %
Climate models (GCM)	4.4 %	1.9 %
Total	79.0 %	89.1 %

Identify climate attributes for land use suitability

Preliminary results shows main influence comes from:

pasture/maize production	Nitrate leaching
- precipitation in summer over 2 months (+) - Number of hot days (-) - Thermal accumulation (+) (maize)	- Intense precipitation in spring over 3 months (+)

In brief

- Future climate change impacts:
  - Pastoral systems
    - production increase but seasonal shift
    - Animal heat stress risk increase
  - Maize production
    - maintained with adaptation, more wheat (catch crop) production
  - Wine grape phenology shift
  - Nitrate leaching
    - increase risk with extreme rainfall, better uptake from catch crops
  - Summer water demand increase especially in Waikato
- Climate attributes could be used as proxies

Implications

- Long-term strategic adaptation needed:
  - Pasture and livestock: manage water, nutrients and shade/shelter
  - Maize: change sowing dates, genotype
  - Wine grape: adapting cultivars, harvest scheduling, more suitable areas

- Tranche 2 of DSC/OLW work plan:
  - climate attributes influencing productive potential across land uses
  - Understanding risk for the primary sector

What next? Understanding risk

Frost occurrence
Drought
Flood

Sensitivity
Growth stages
Livestock heat tolerance

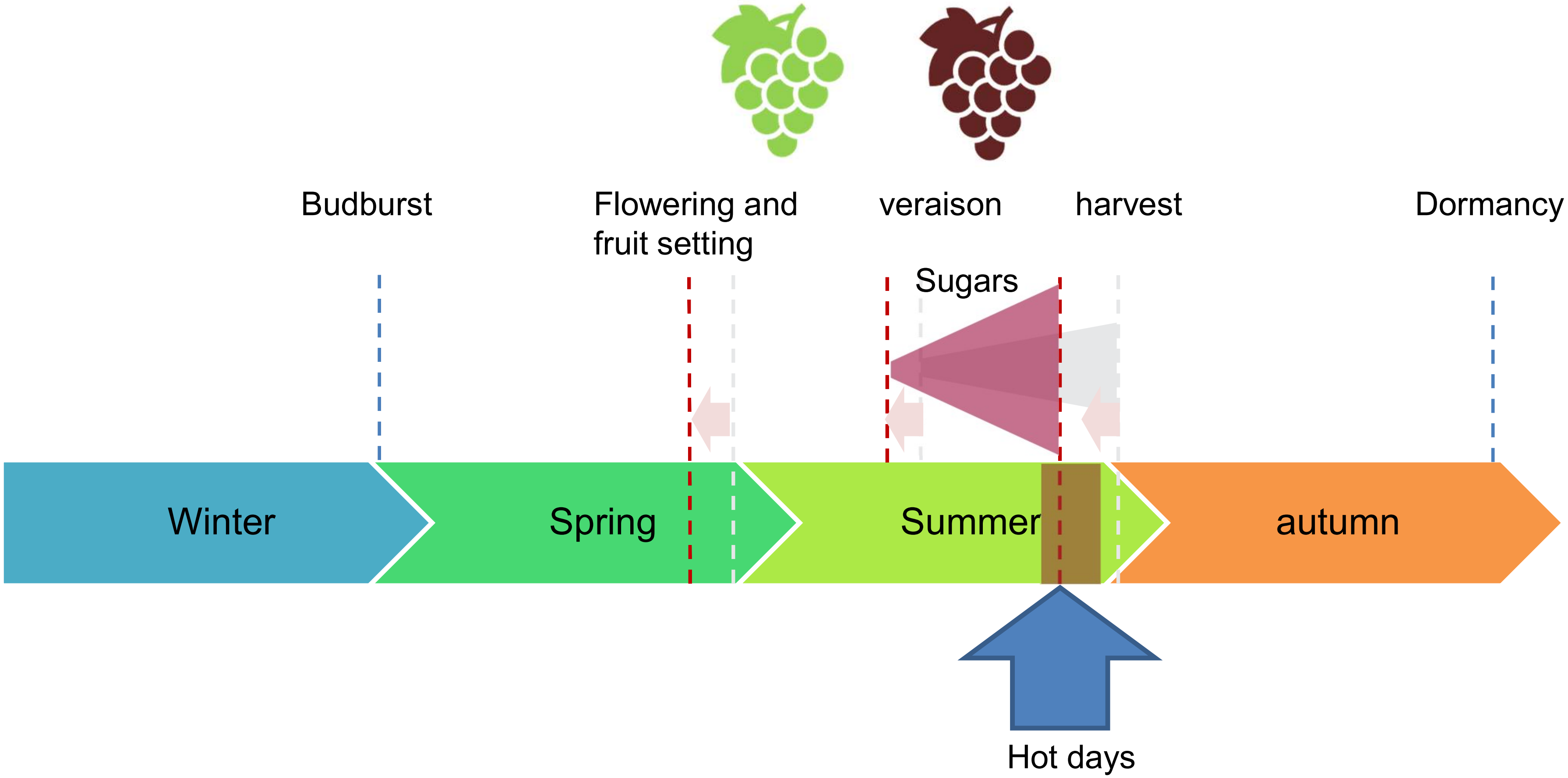
Adaptive capacity
Management options (sowing dates, irrigation, …)

Where the land uses are

from IPCC

➡ To identify hotspots and inform adaptation strategies

Example: climate change risk for wine grape



Risk for working conditions/fruit quality during harvest, wine quality (acidity and alcohol levels)

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