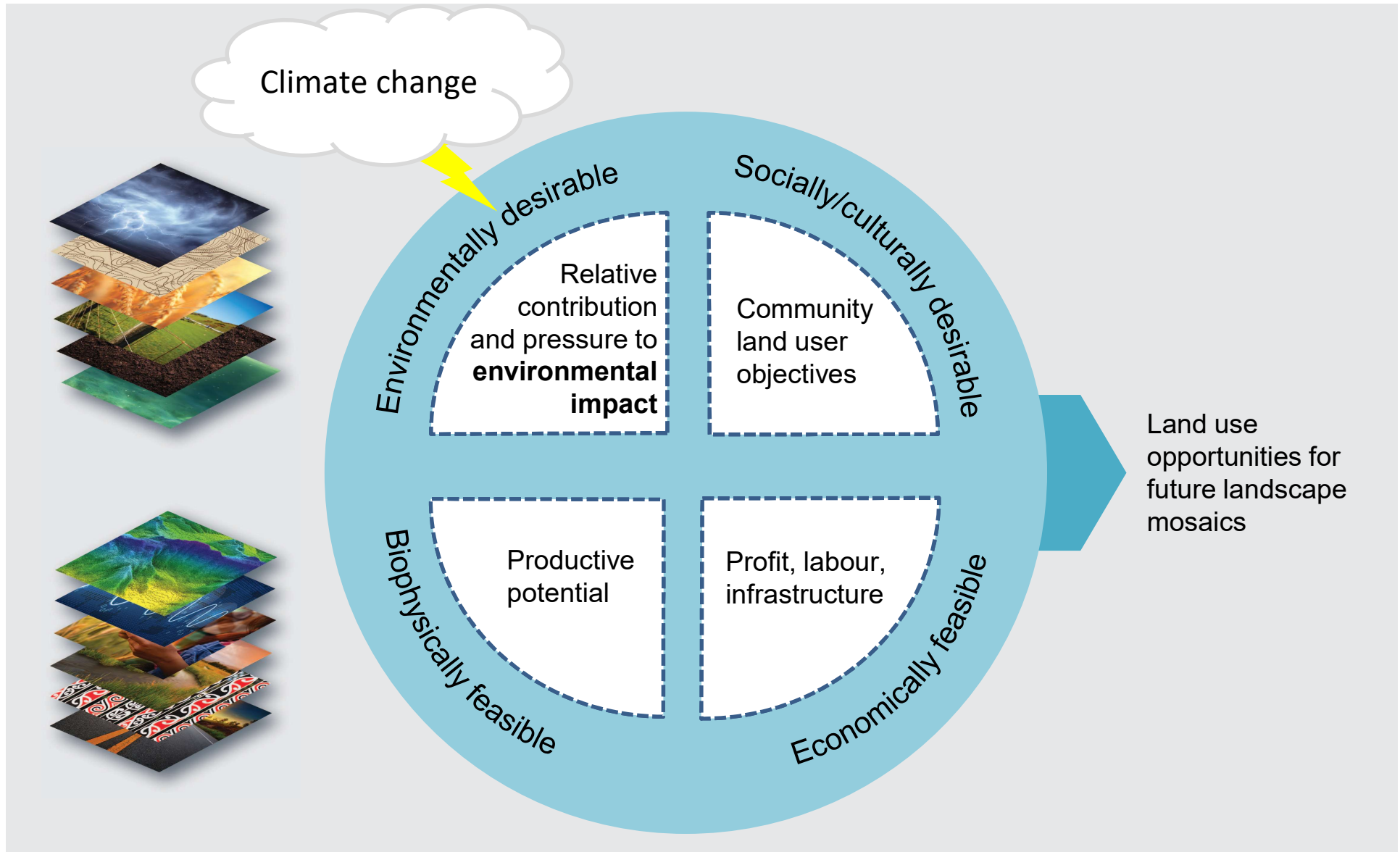


Climate change impacts on land use suitability

Anne-Gaelle Ausseil, Tony van der Weerden, Mike Beare,
Troy Baisden, Edmar Teixeira, Liz Keller, Mark Lieffering,
Jing Guo, Richard Law



What is land use suitability?



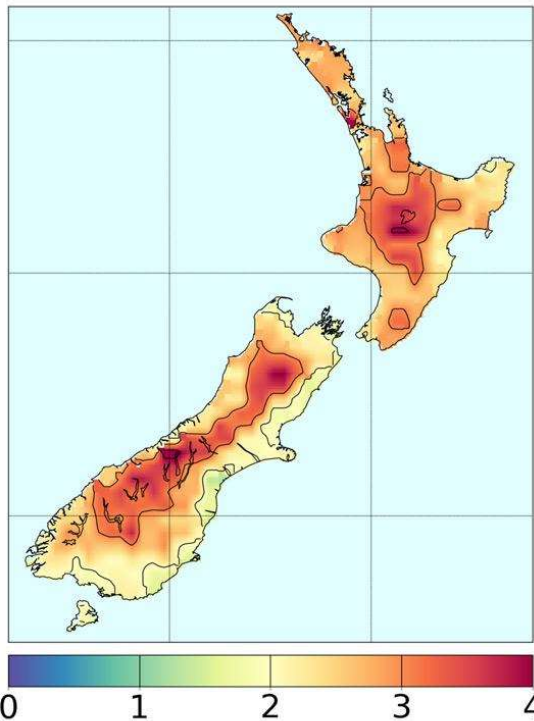
Climate Change long-term projections

Hotter everywhere

Drier in summer

Wetter on the SW in winter

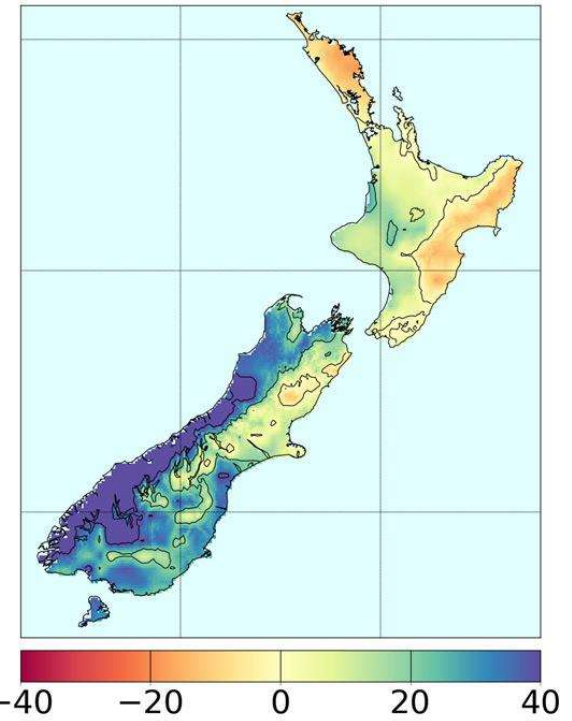
Tmean: RCP8.5, 2090, DJF



Precipitation: RCP8.5, 2090, DJF



Precipitation: RCP8.5, 2090, JJA



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

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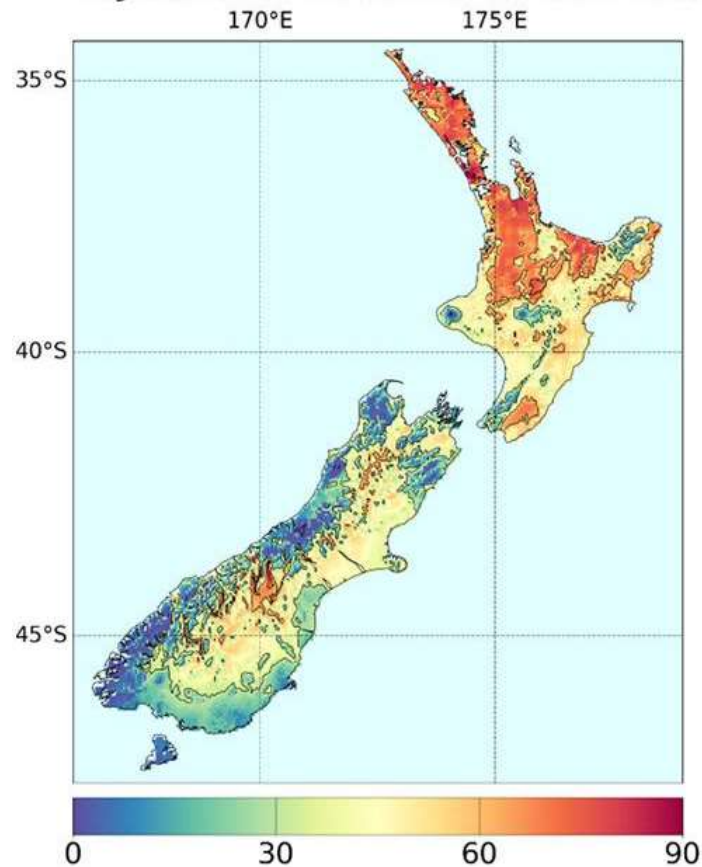
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Projected changes in extremes

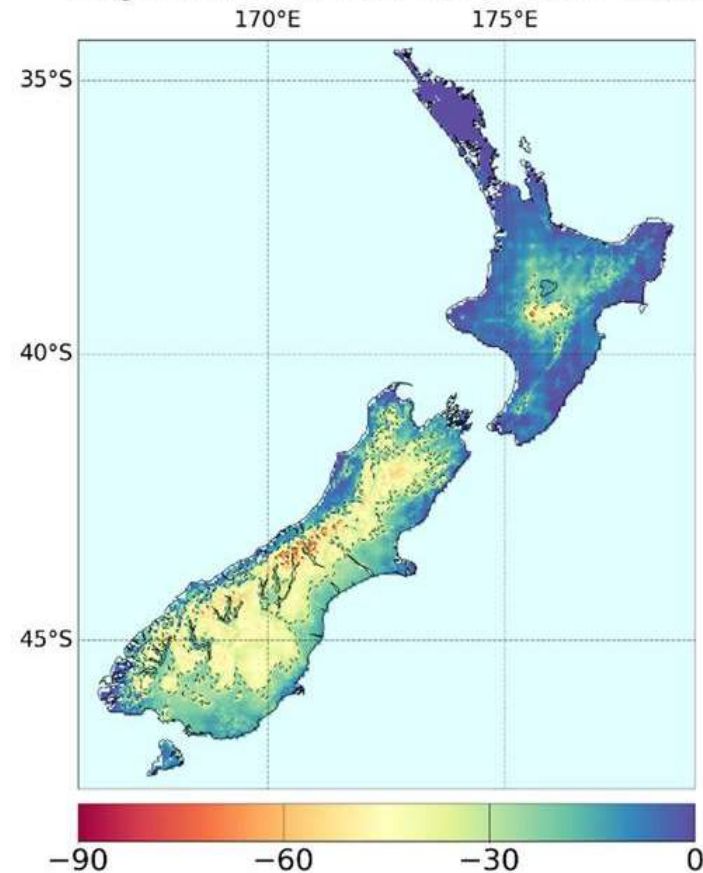
More hot days in summer

Days above 25: RCP8.5 , 2090 change



Less cold days

Days below 0: RCP8.5 , 2090 change



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

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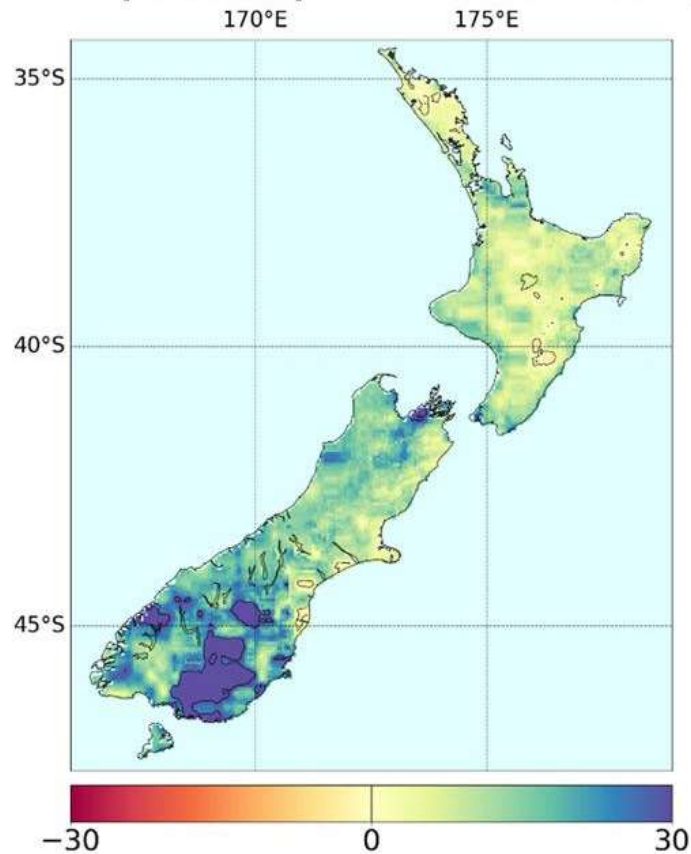
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Projected changes in extremes

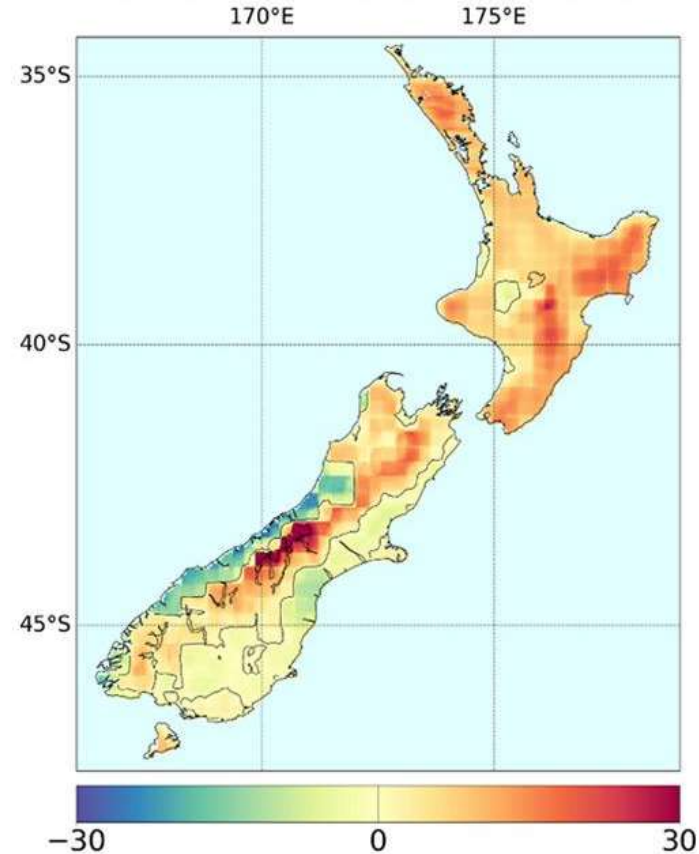
More intense rainfall in the South

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

99-pctl Precip: RCP8.5 , 2090 change



Dry Days: RCP8.5 , 2090 change



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

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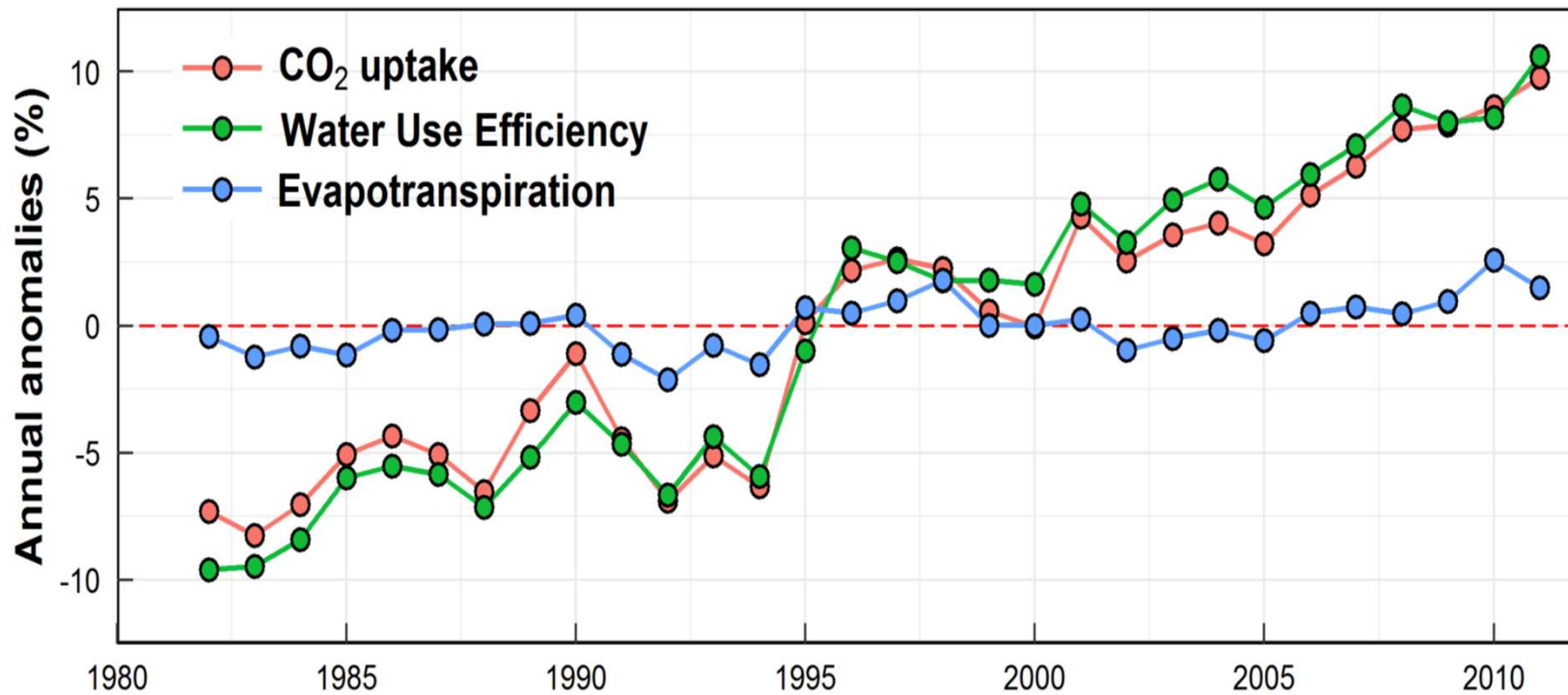
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Rising CO₂ makes plant more water-efficient

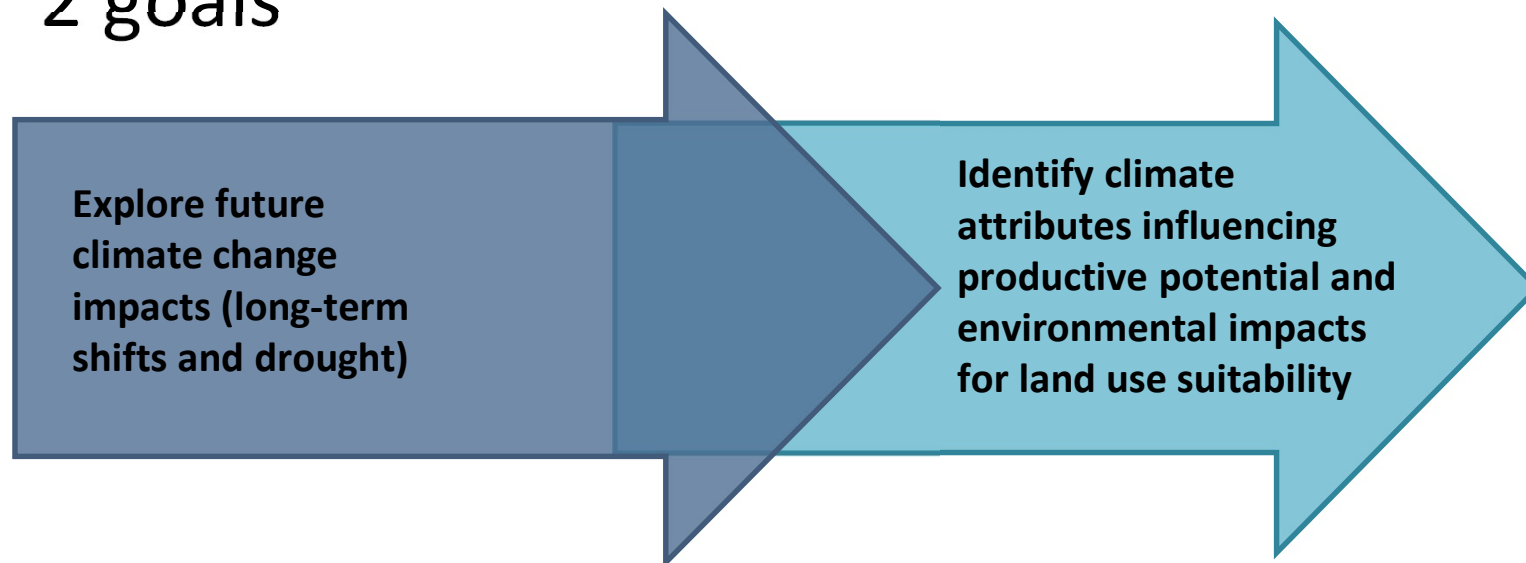
Global production from land plants up 15-20% with 0.7°C temperature change



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

Objectives

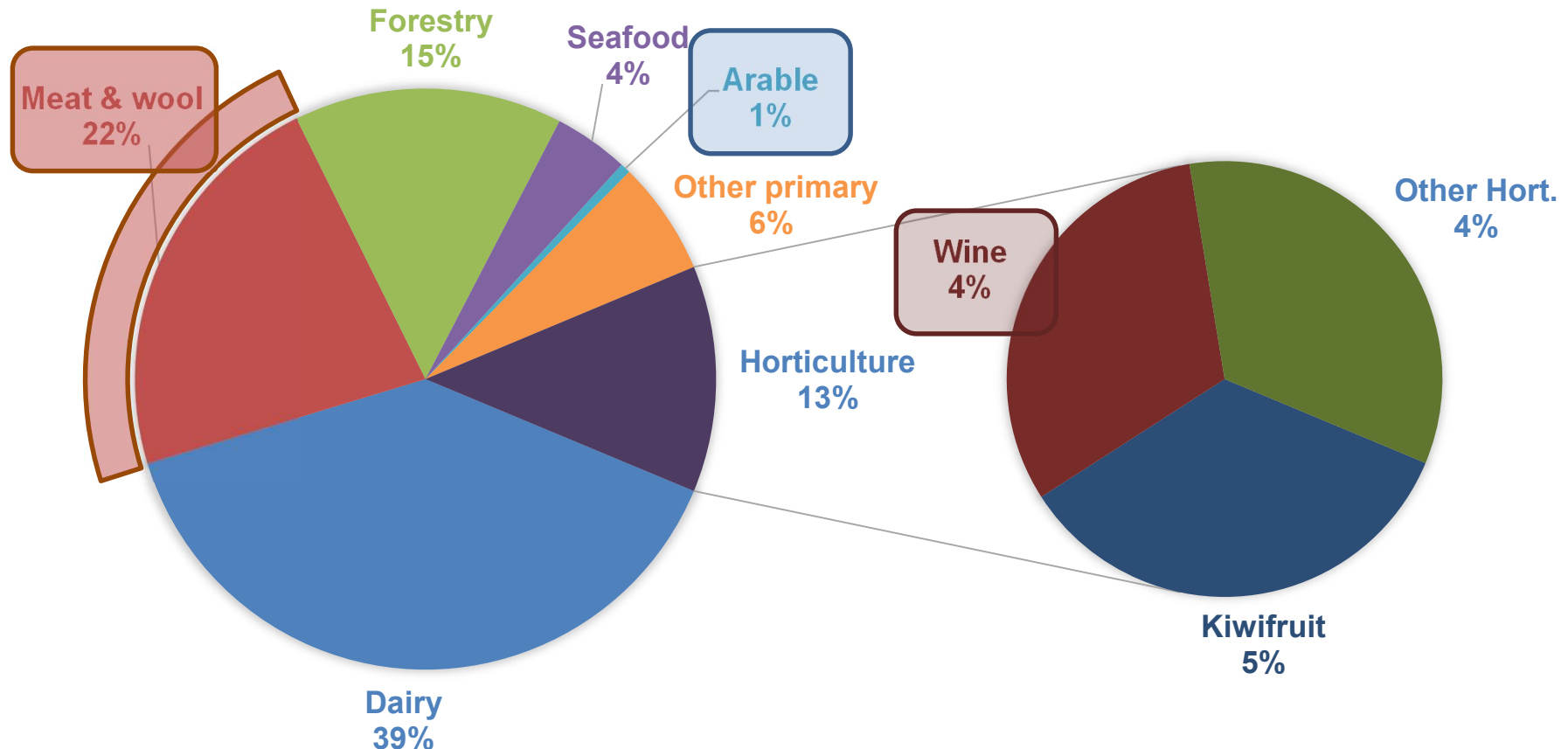
- 2-year project (2017-2019)
- 2 goals



\$43 Billion in Primary Exports

Where did we focus?

2018 Data from [SOPI](#)



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

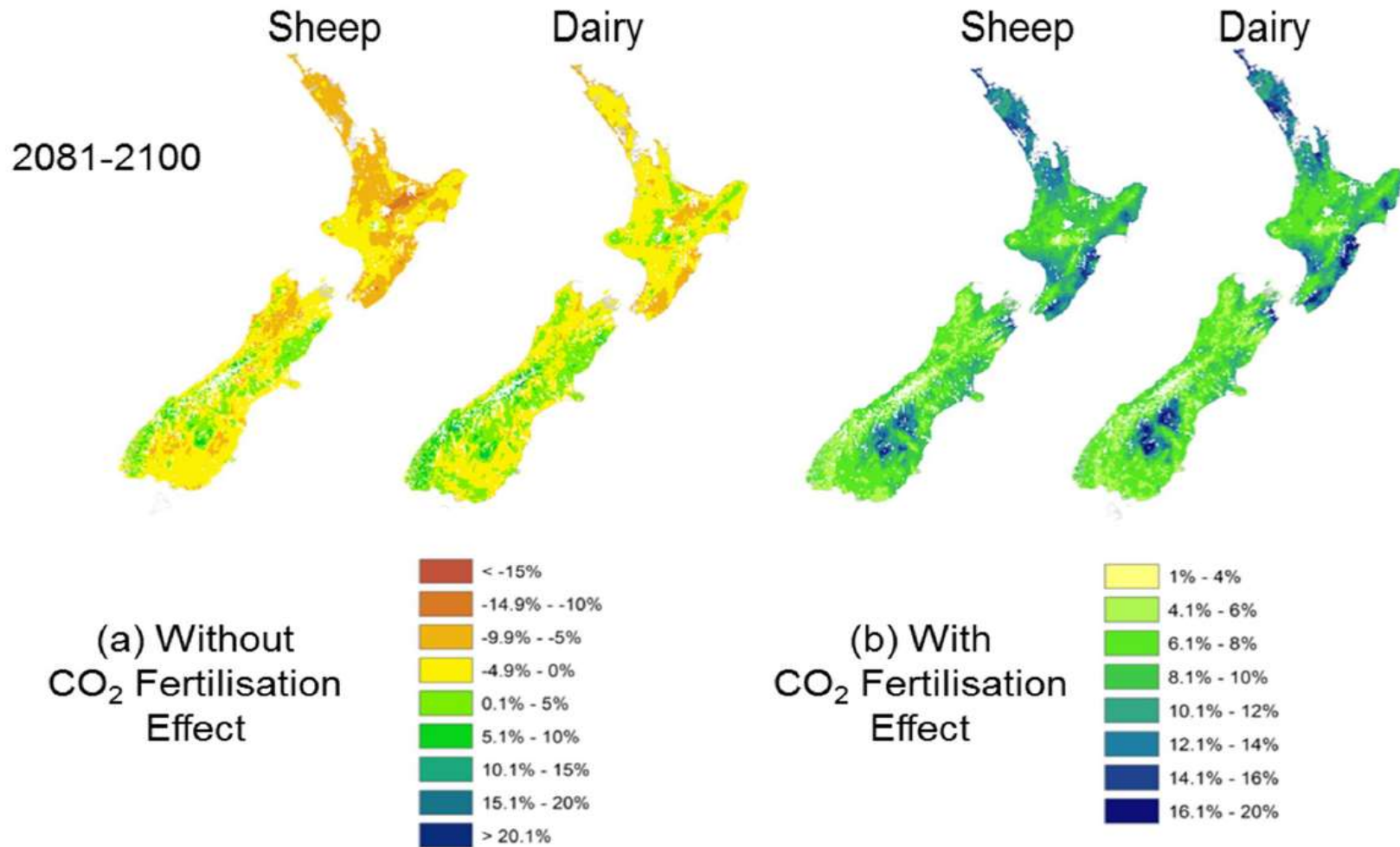
Method and scale of analysis

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	✗	✗	✗

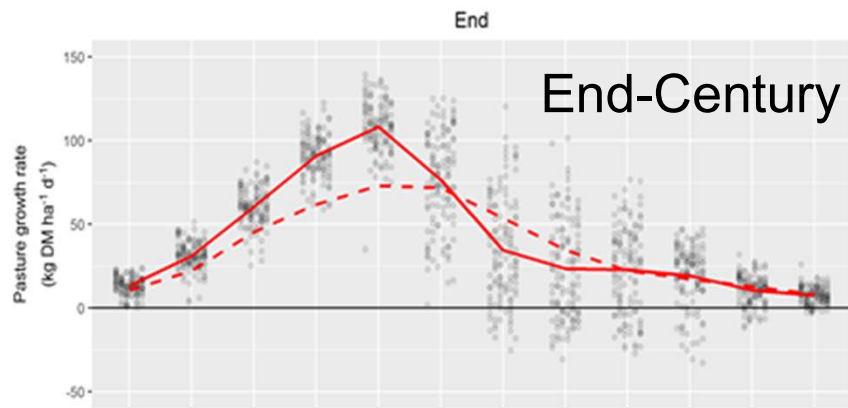
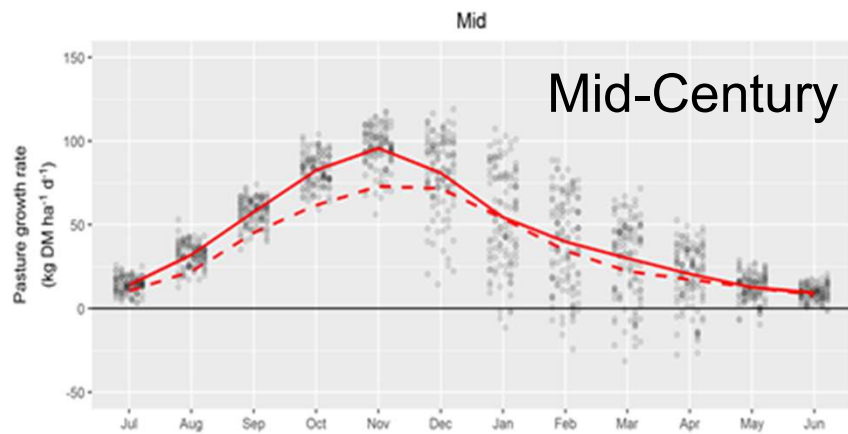
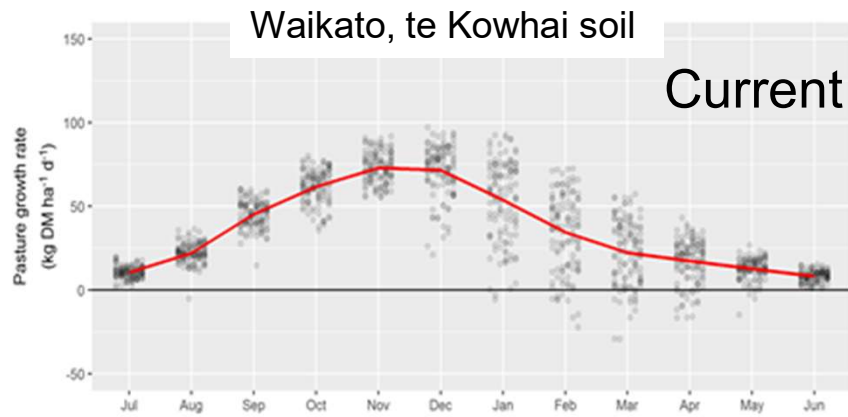
Exploring future climate change impacts

- 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)

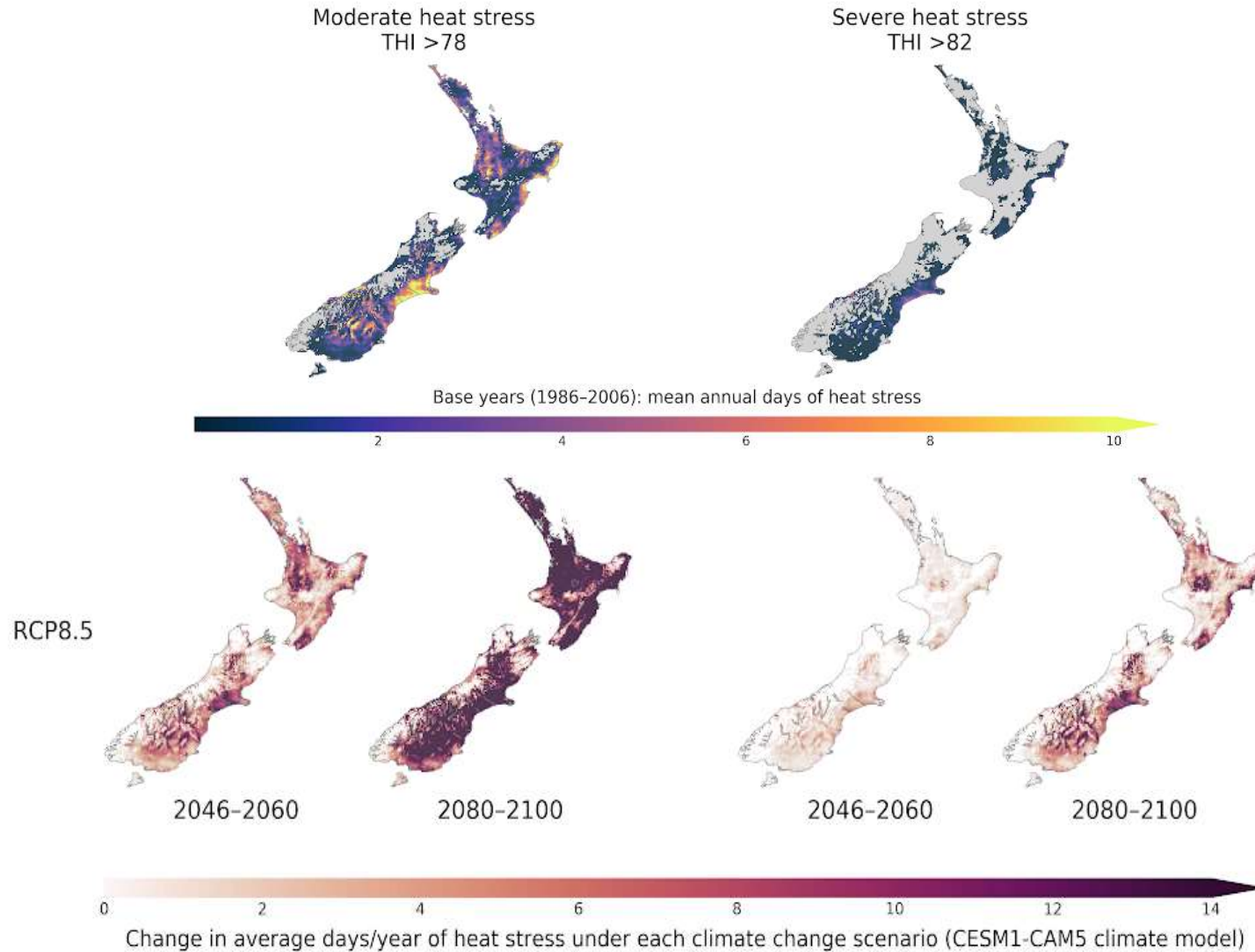


Month: J A S O N D J F M A M J

Pasture yield

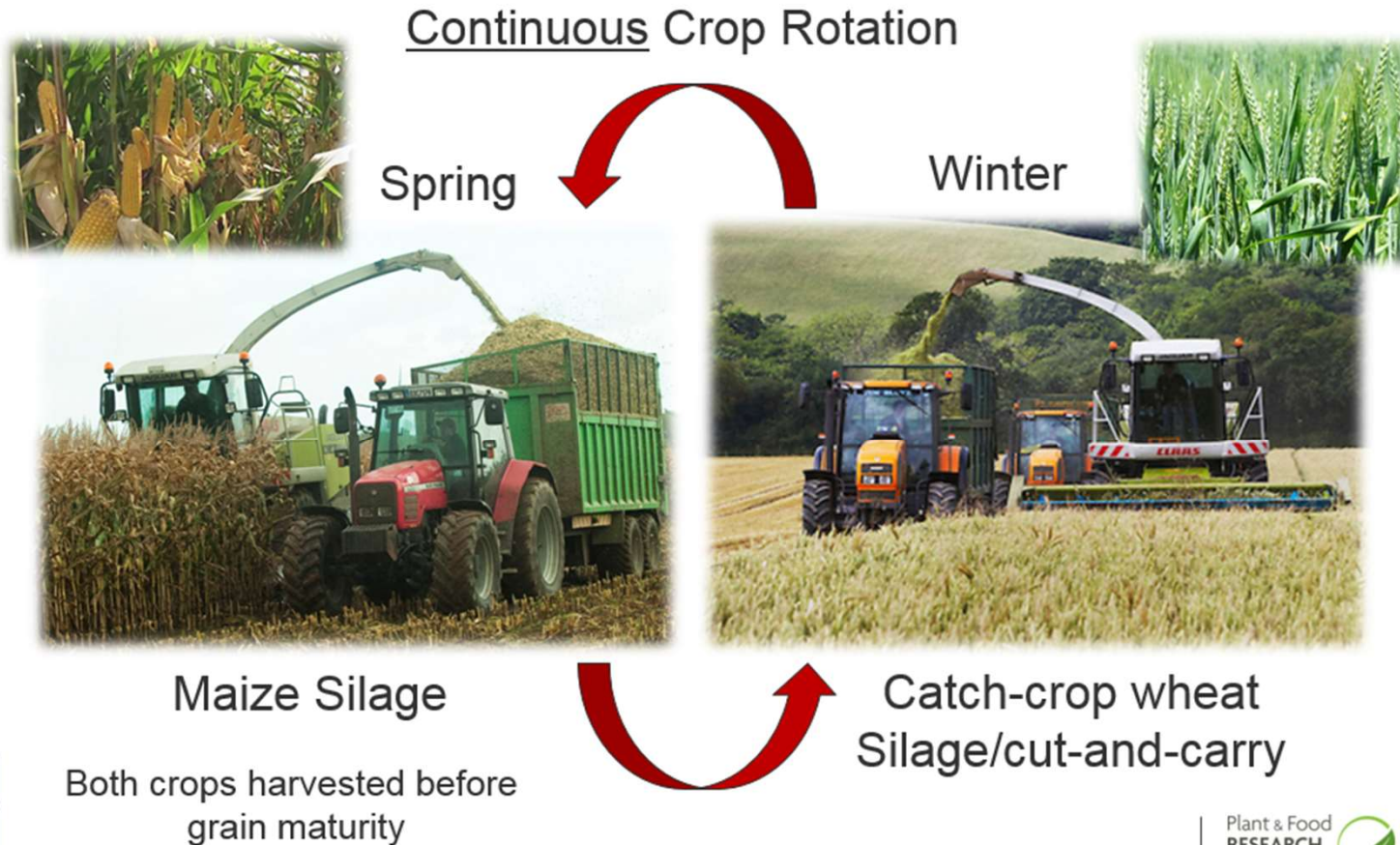
- Shift in monthly pasture growth rates:
 - Higher spring peak
 - Lower in summer
- Variability in soils and regions and climate models
- Influences feed stock management

Change in animal heat stress risk

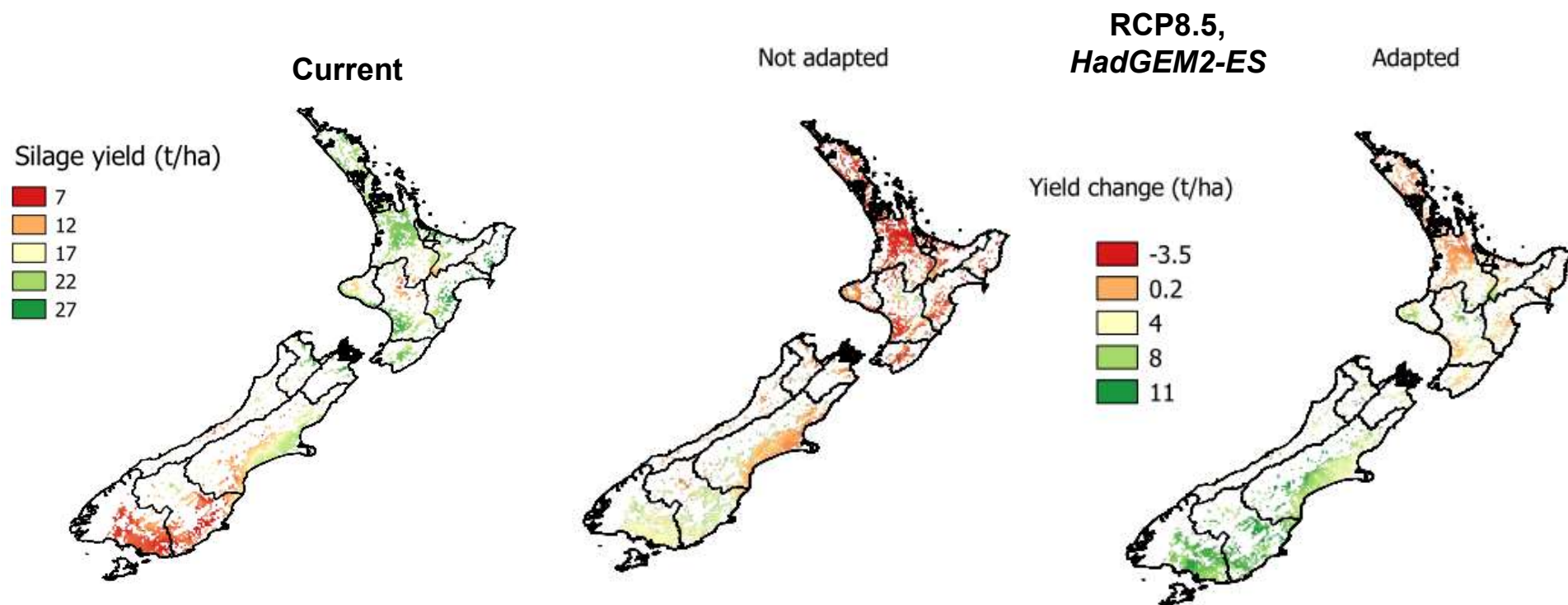


Cropping systems

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



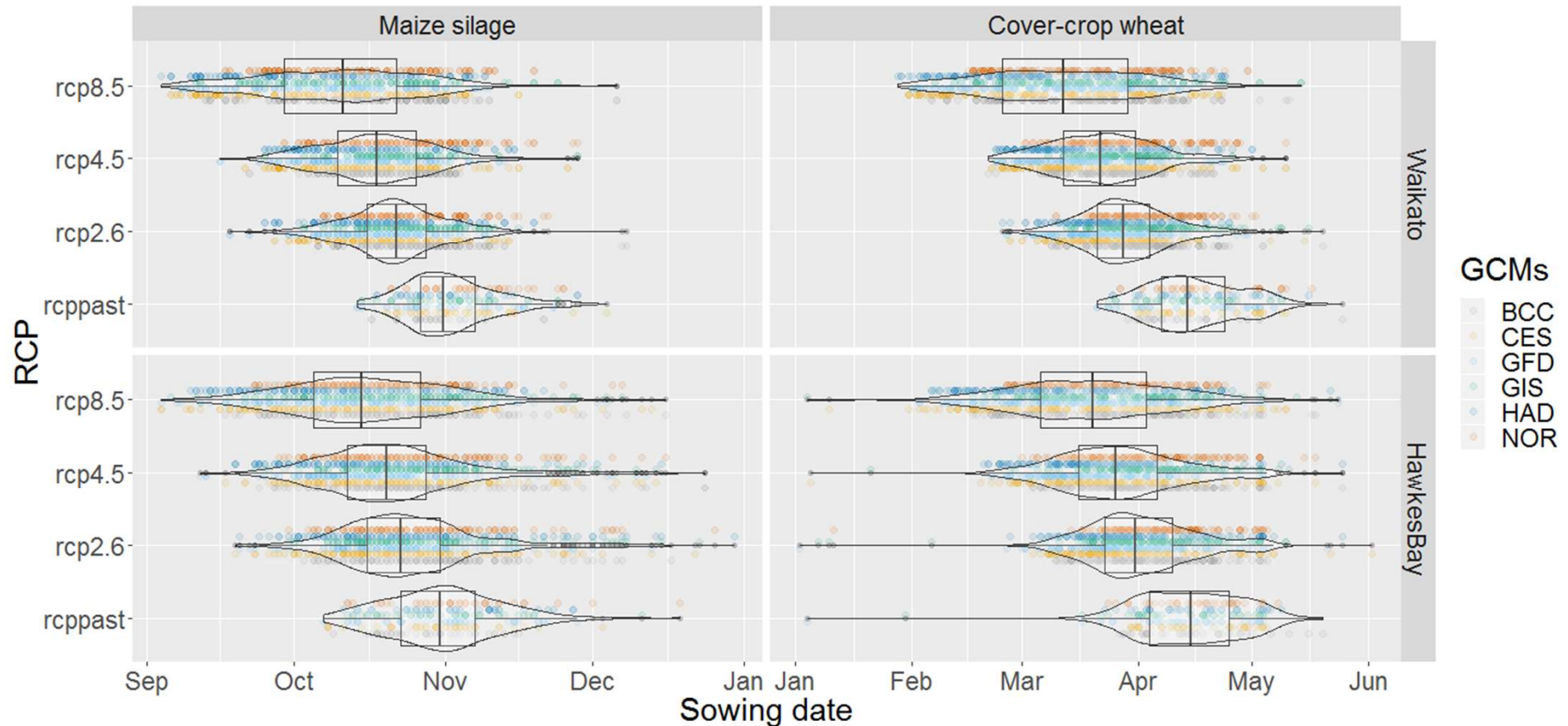
CCII: impact of climate change on irrigated maize production and adaptation



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

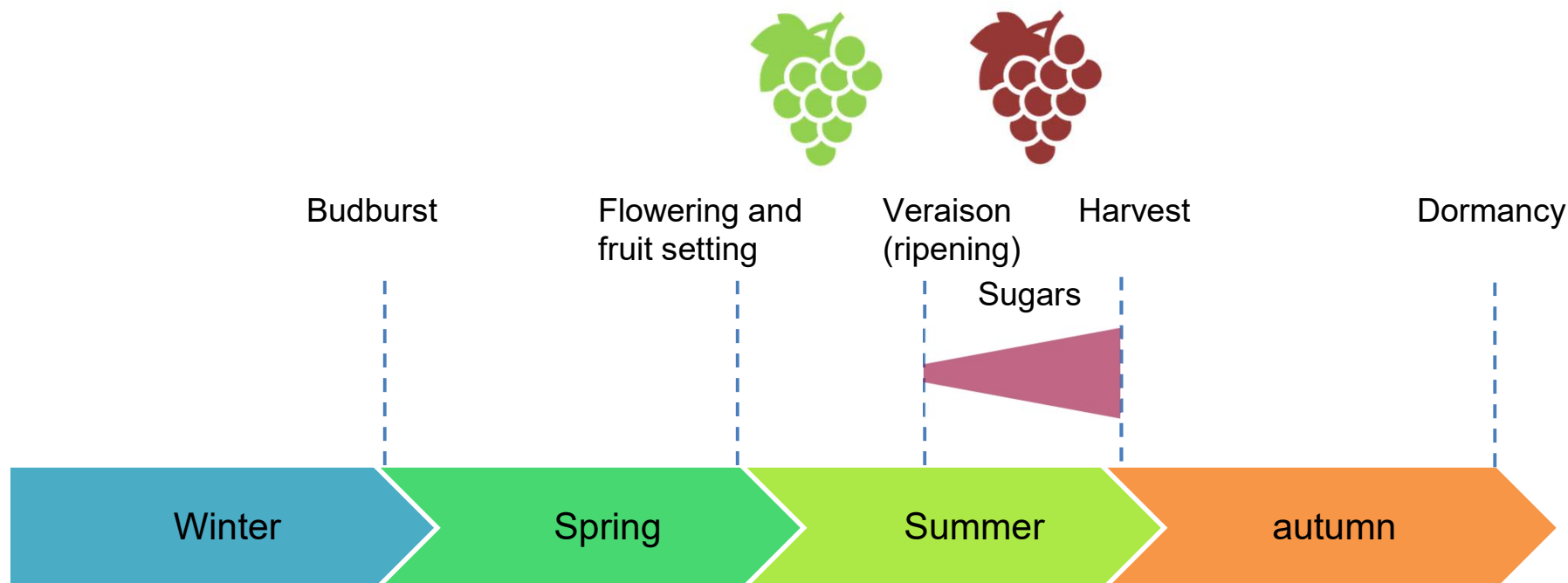
Rutledge et al. (2017). CCII synthesis report.

Cropping systems (end of century)



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

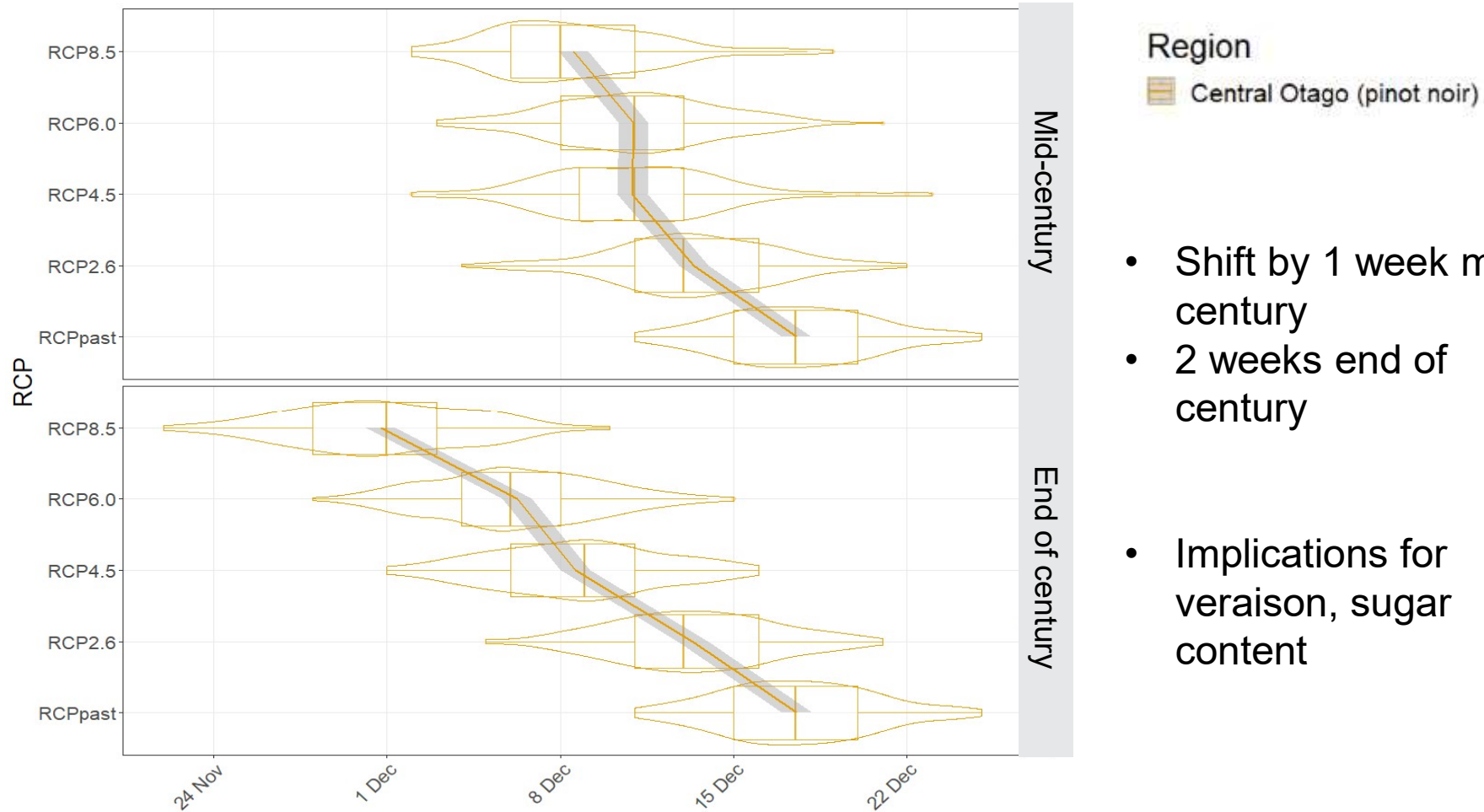
The growth stages of wine grapes



Thermal accumulation affects timing of growth stages

Co-funded by Manaaki Whenua, Amber Parker Lincoln University

Shift in flowering dates



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

- Implications for veraison, sugar content

Co-funded by Manaaki Whenua, Amber Parker Lincoln University

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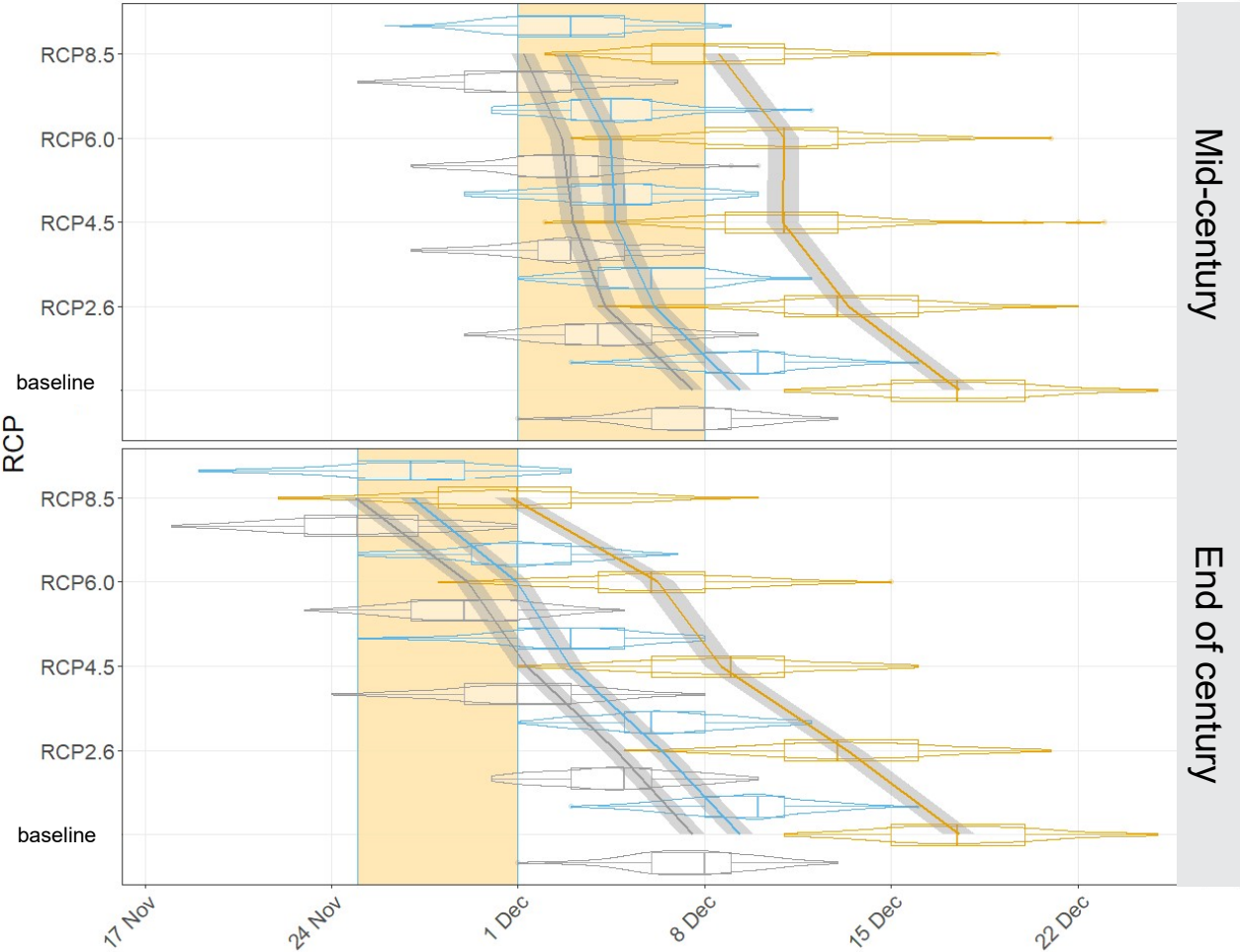
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Shift in flowering dates



Region

- Hawke's Bay Region (merlot)
- Central Otago (pinot noir)
- Marlborough (Sauvignon blanc)

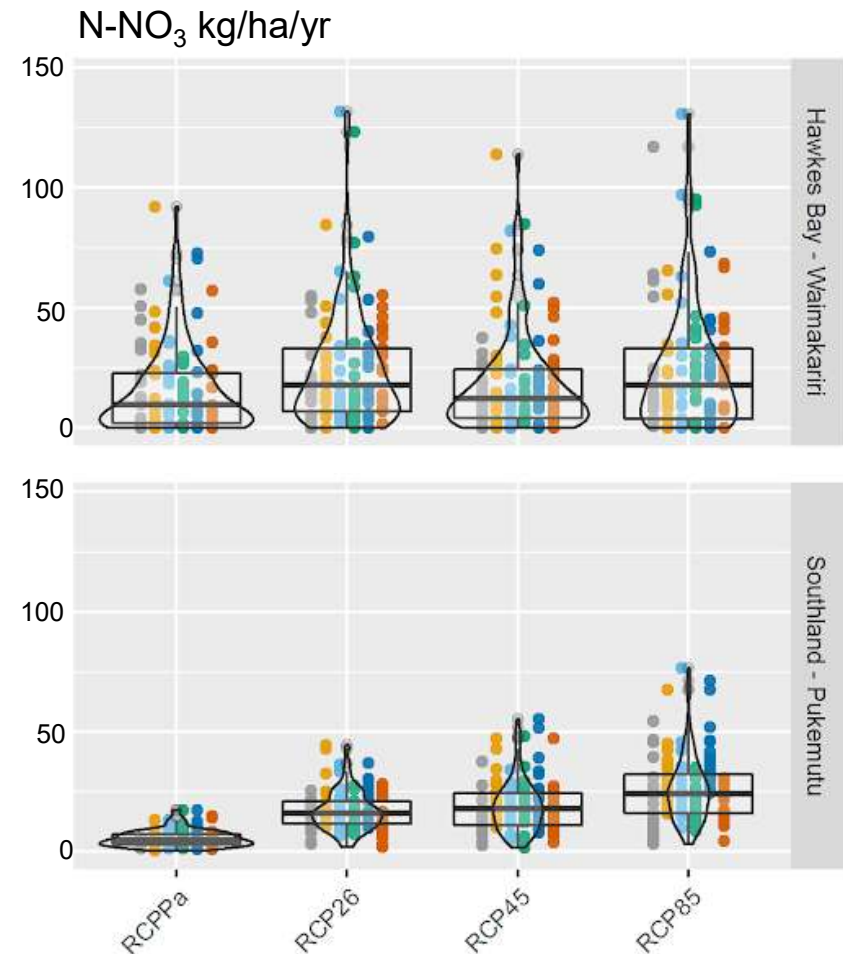
Compression time in flowering dates between the 3 major cultivars in Hawkes Bay, Central Otago and Marlborough

Implications for harvesting scheduling

Co-funded by Manaaki Whenua, Amber Parker Lincoln University

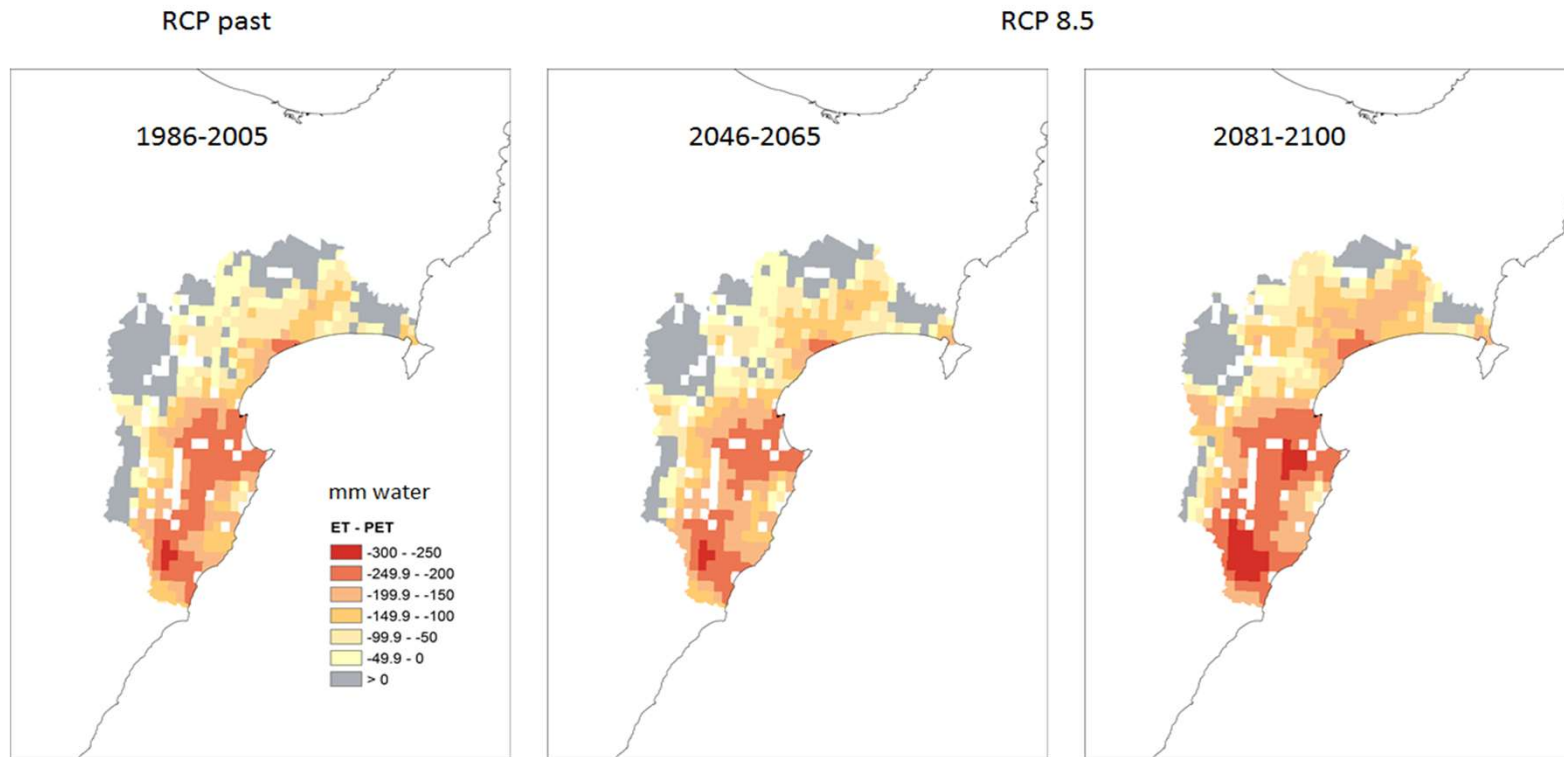
Nitrate leaching in pasture/maize

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



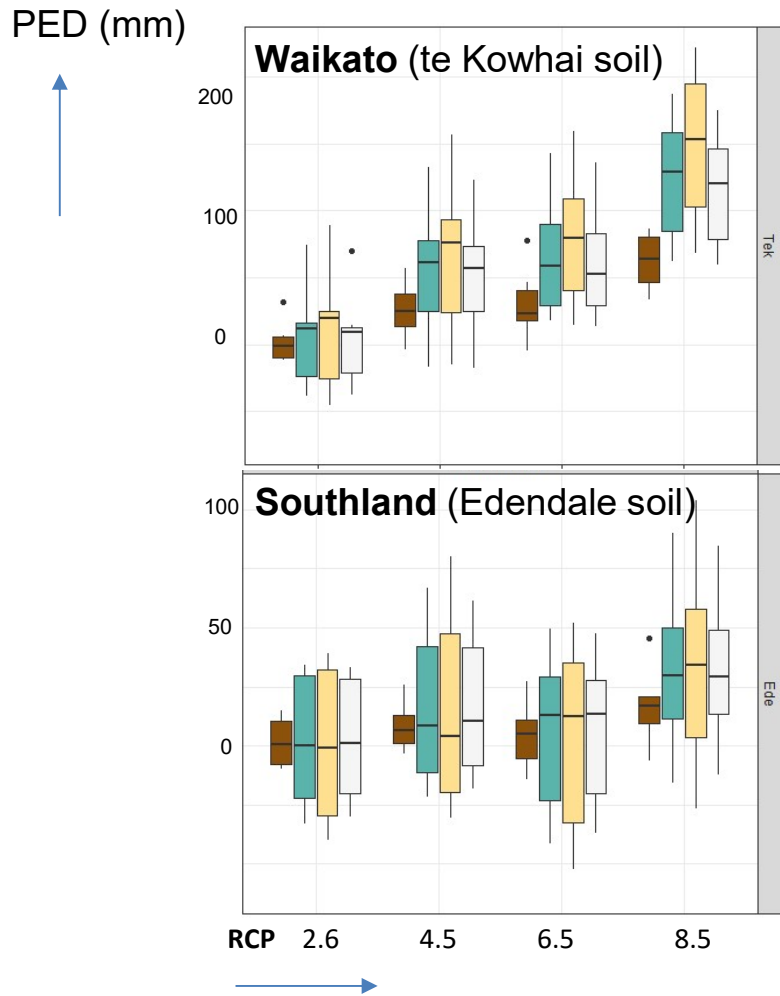
Extract from pasture results (End of century)

Change in water demand (summer)



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

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
<ul style="list-style-type: none">- precipitation in summer over 2 months (+)- Number of hot days (-)- Thermal accumulation (+) (maize)	<ul style="list-style-type: none">- 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

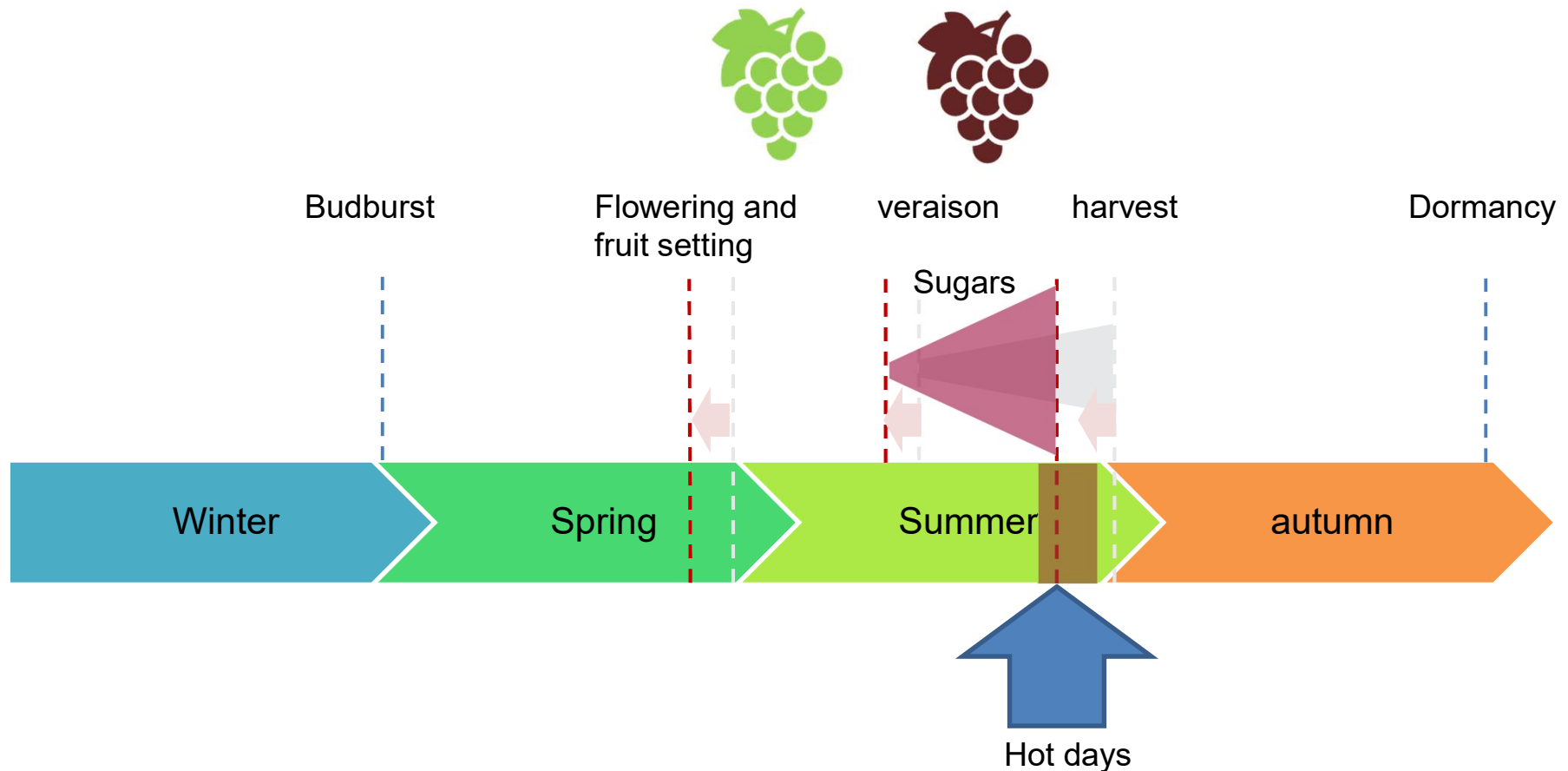
- Long-term strategic adaptation needed:
 - Pasture and livestock: manage water, nutrients and shade/shelter
 - Maize: change sowing dates, genotype
 - Wine grape: adapting cultivars, harvest scheduling, more suitable areas
- Tranche 2 of DSC/OLW work plan:
 - climate attributes influencing productive potential across land uses
 - Understanding risk for the primary sector

What next? Understanding risk



➔ 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)