Climate Change : Impacts on Crops

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2 September 2022

CAPITAL THINKING.
GLOBALLY MINDED.
MAI I TE IHO KI TE PAE

1897

VICTORIA UNIVERSITY OF
WELLINGTON
TE HERENGA WAKA

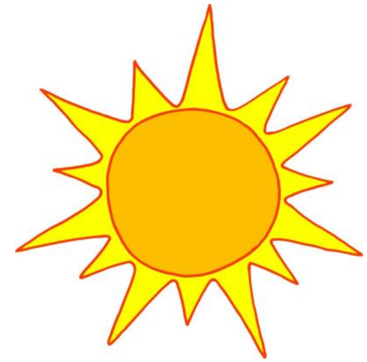
OUTLINE

- Temperature change
- Precipitation change
- What these changes mean
- Changes for corn, wheat and cooler climate crops
- Heatwaves
- Adaptation

20th century

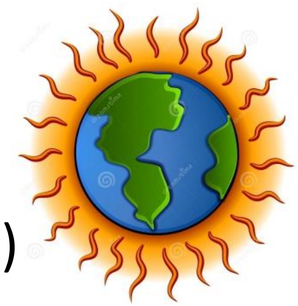
21st century

CLIMATE CHANGE 101



The sun emits (mostly) visible light

- Absorbed by the earth



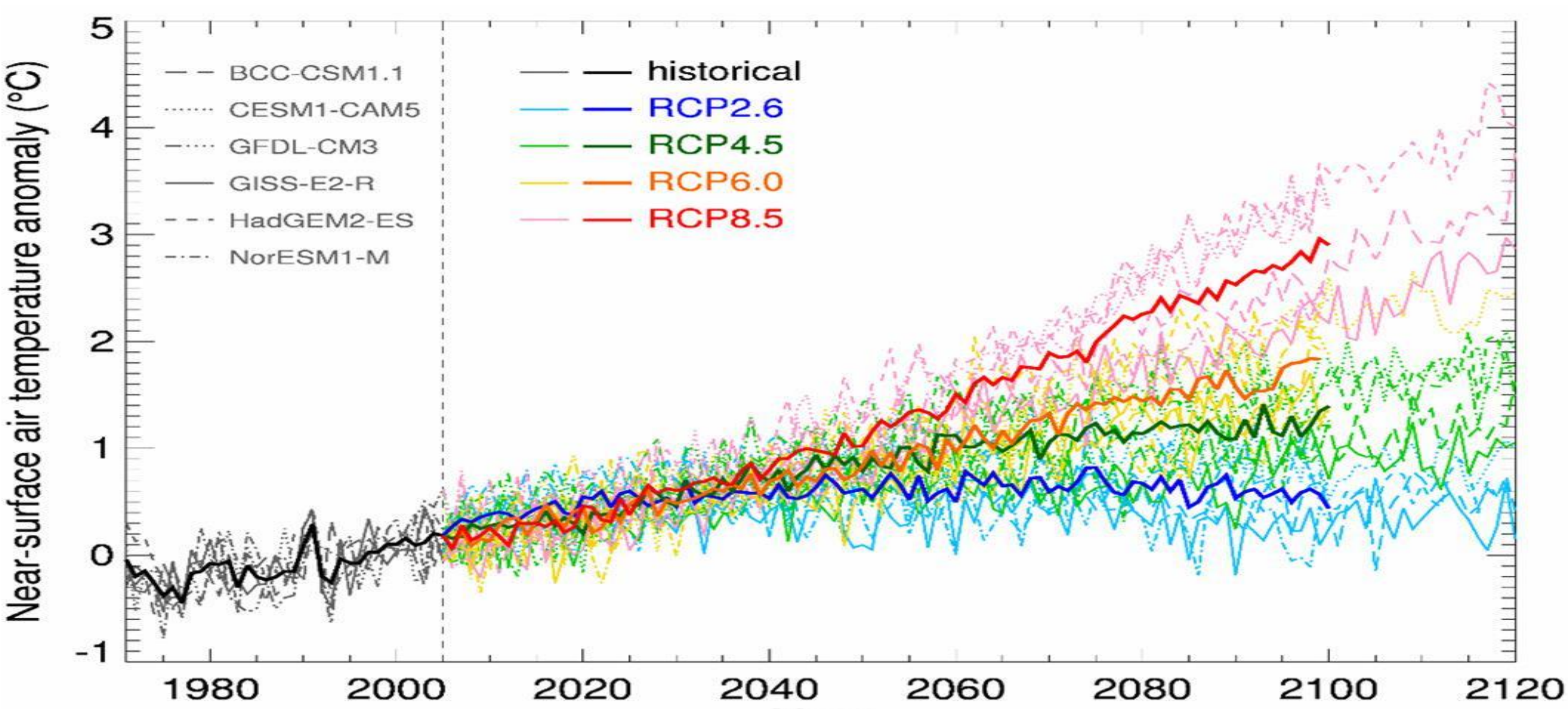
The earth emits heat (infrared) radiation

- Absorbed (and re-radiated) by the atmosphere
  - By “greenhouse” gases (carbon dioxide, water vapour, etc)

Change the climate by

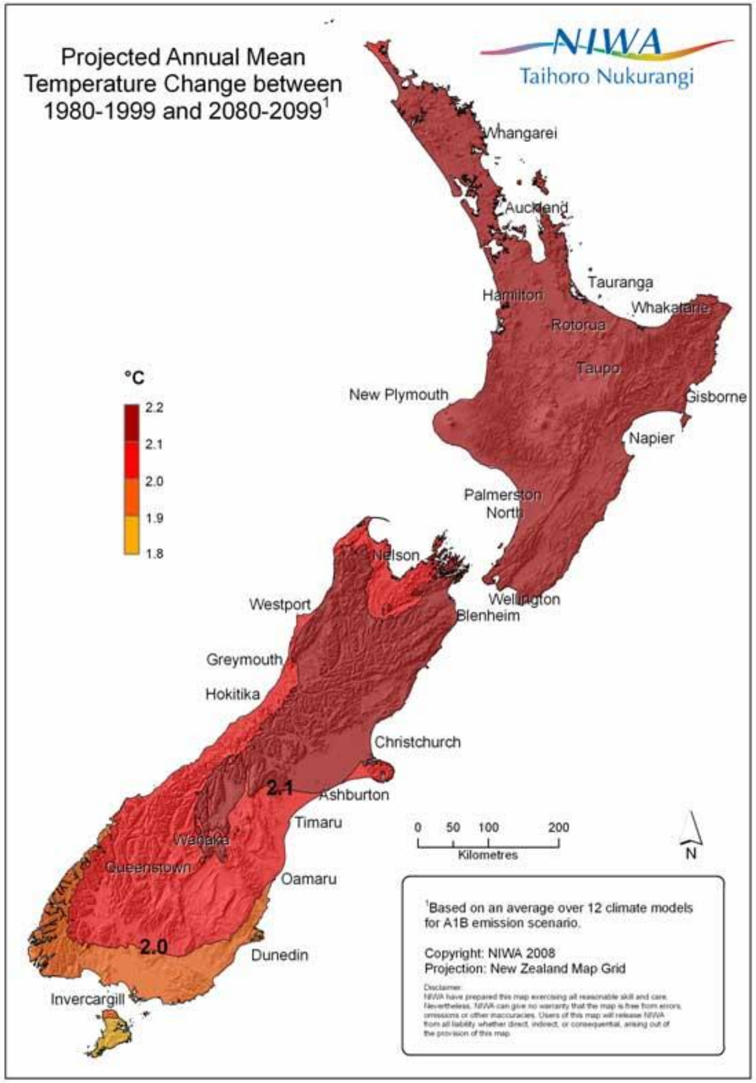
- Changing sunlight
- Changing greenhouse gas amounts

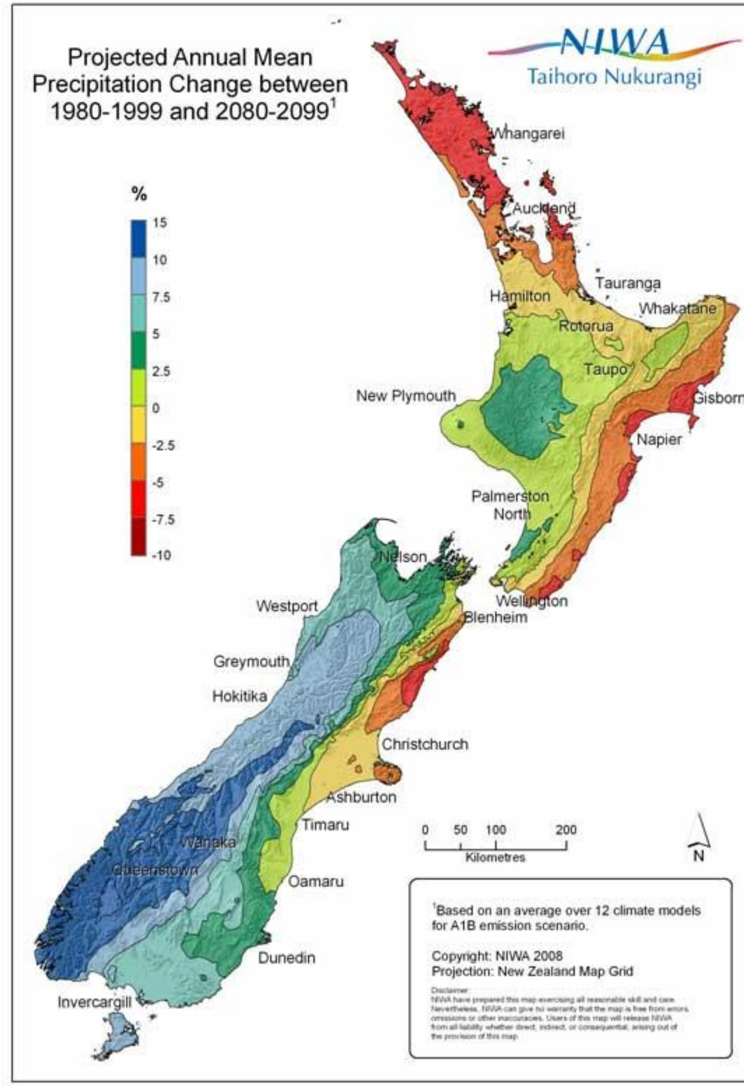
THE FUTURE - TEMPERATURE



Compared to 1995, temperatures are likely to be 0.5˚C to 1.5˚C warmer by 2040 and 0.6˚C to 3.5˚C warmer by 2090. By 2090, extra days per year where maximum temperatures exceed 30˚C, with around 10 to 15 fewer frosts days per year at 2040 and 20 to 40 days at 2090.

CLIMATE PROJECTIONS





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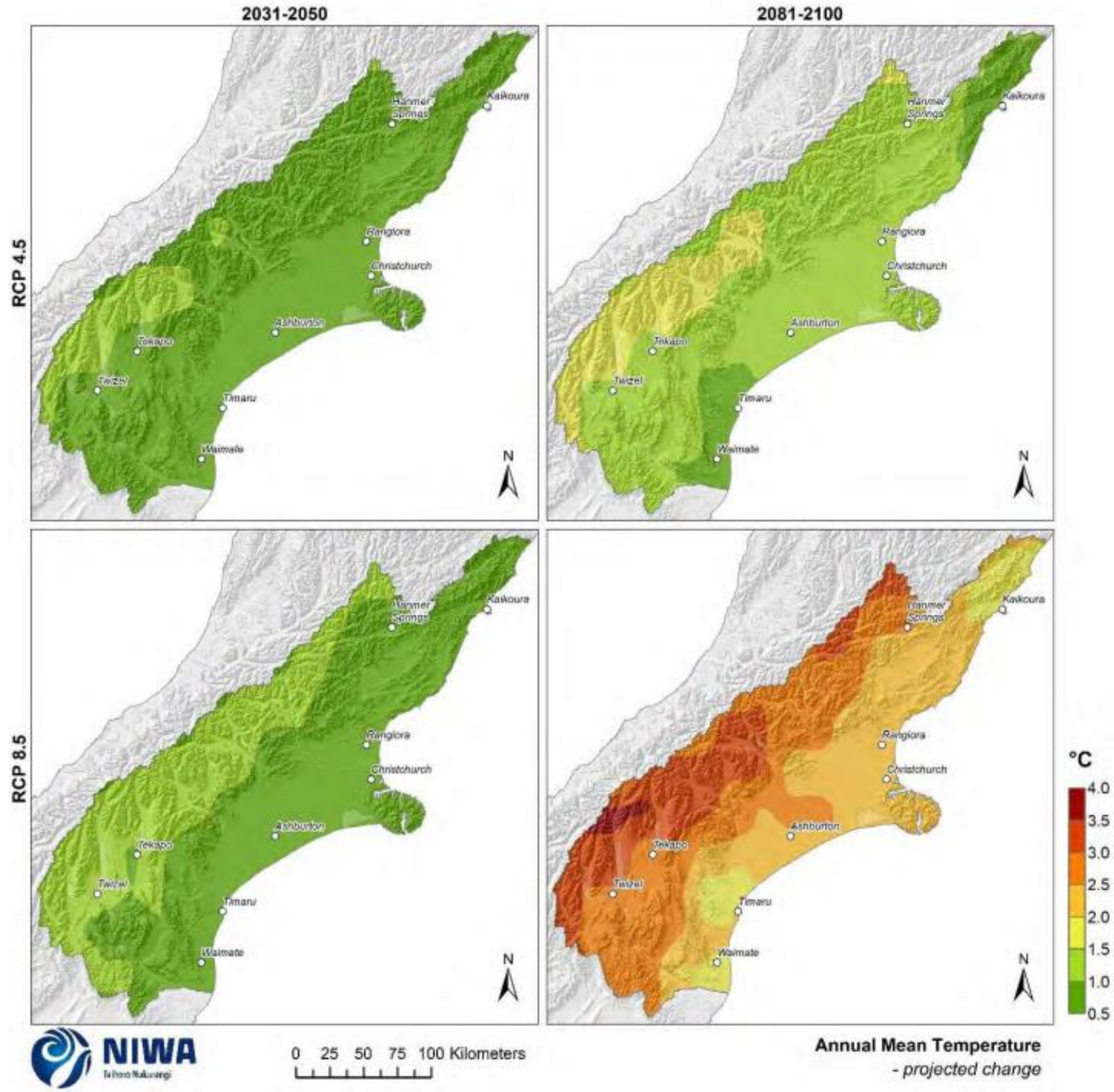

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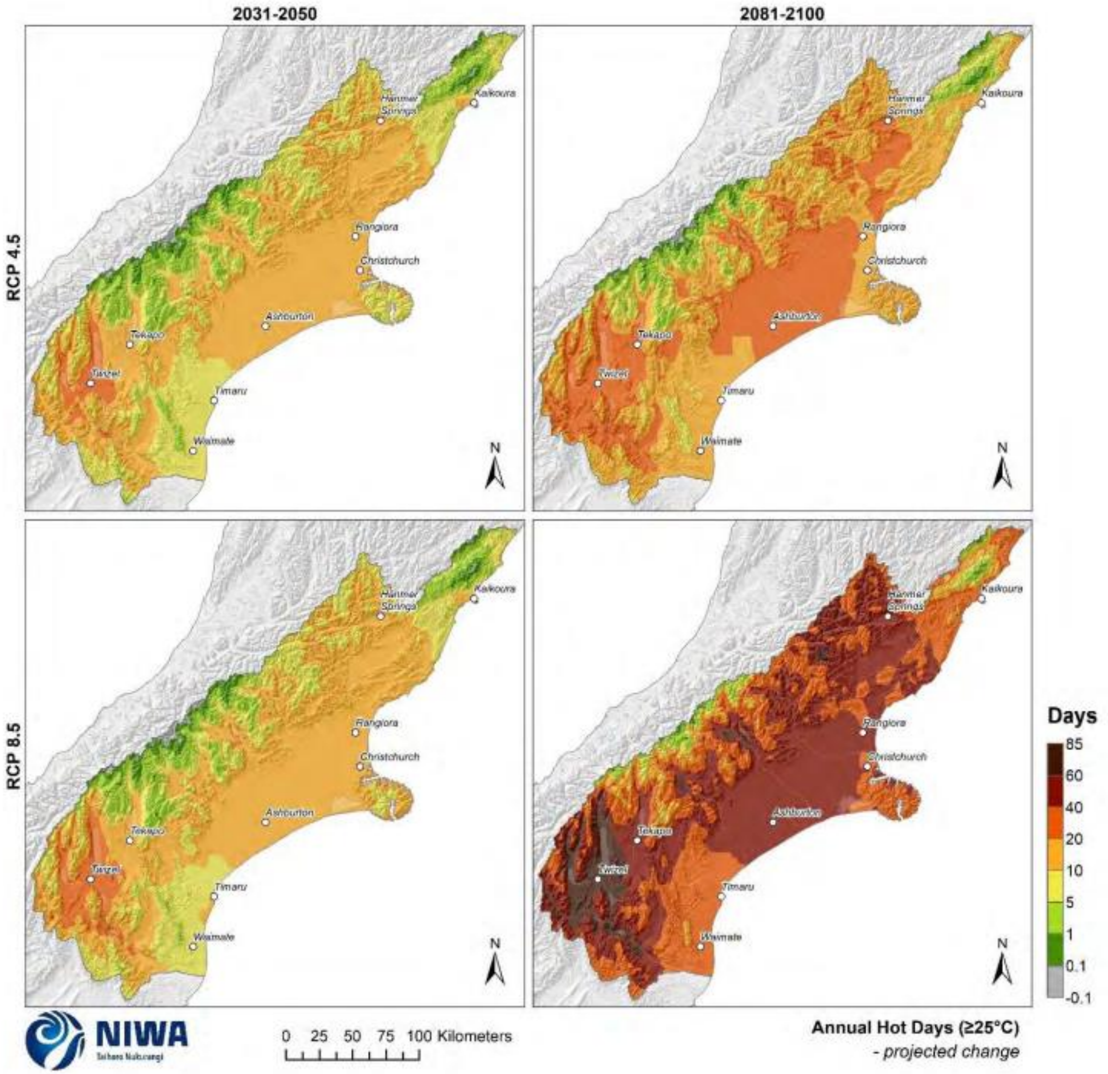

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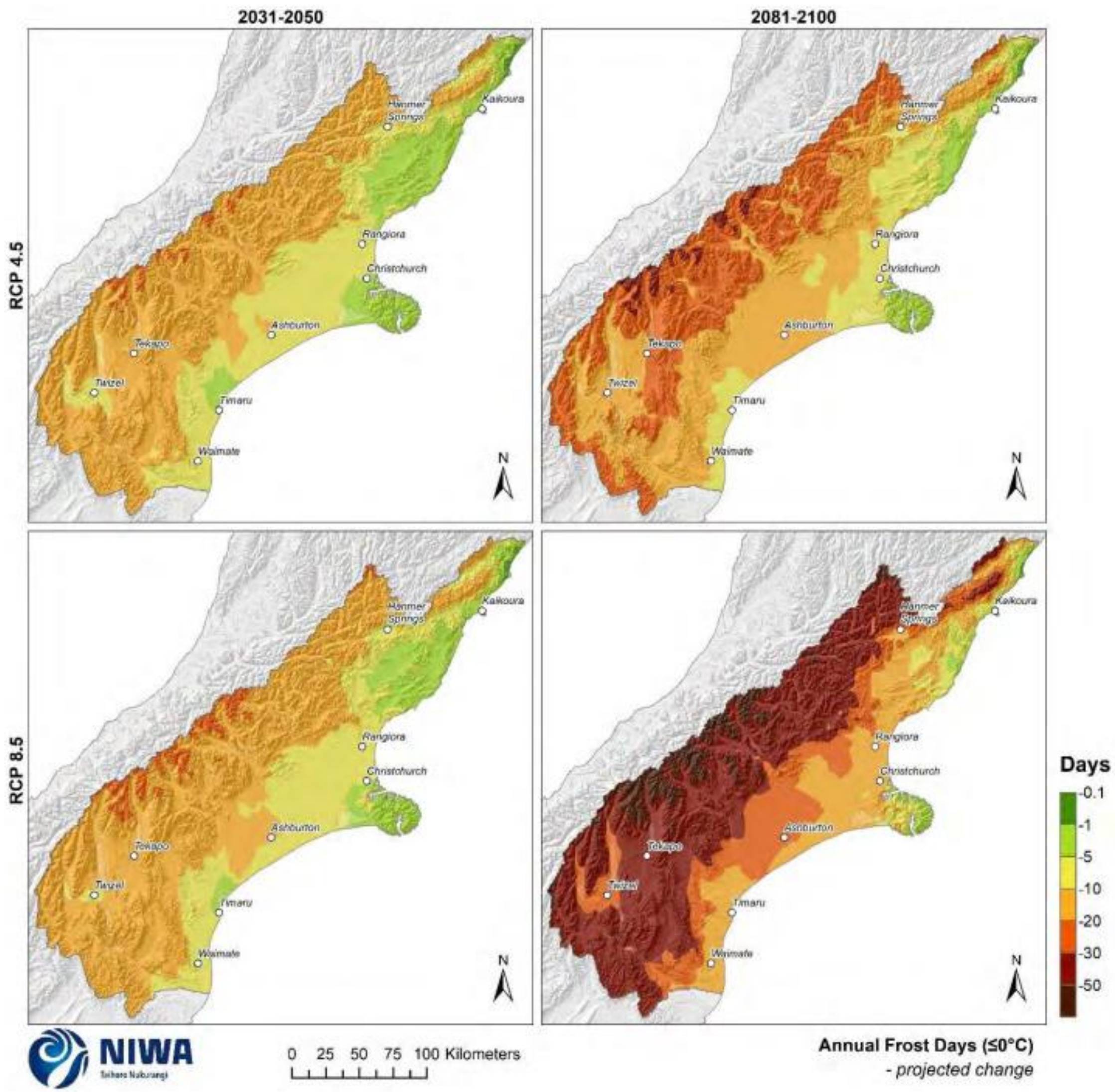

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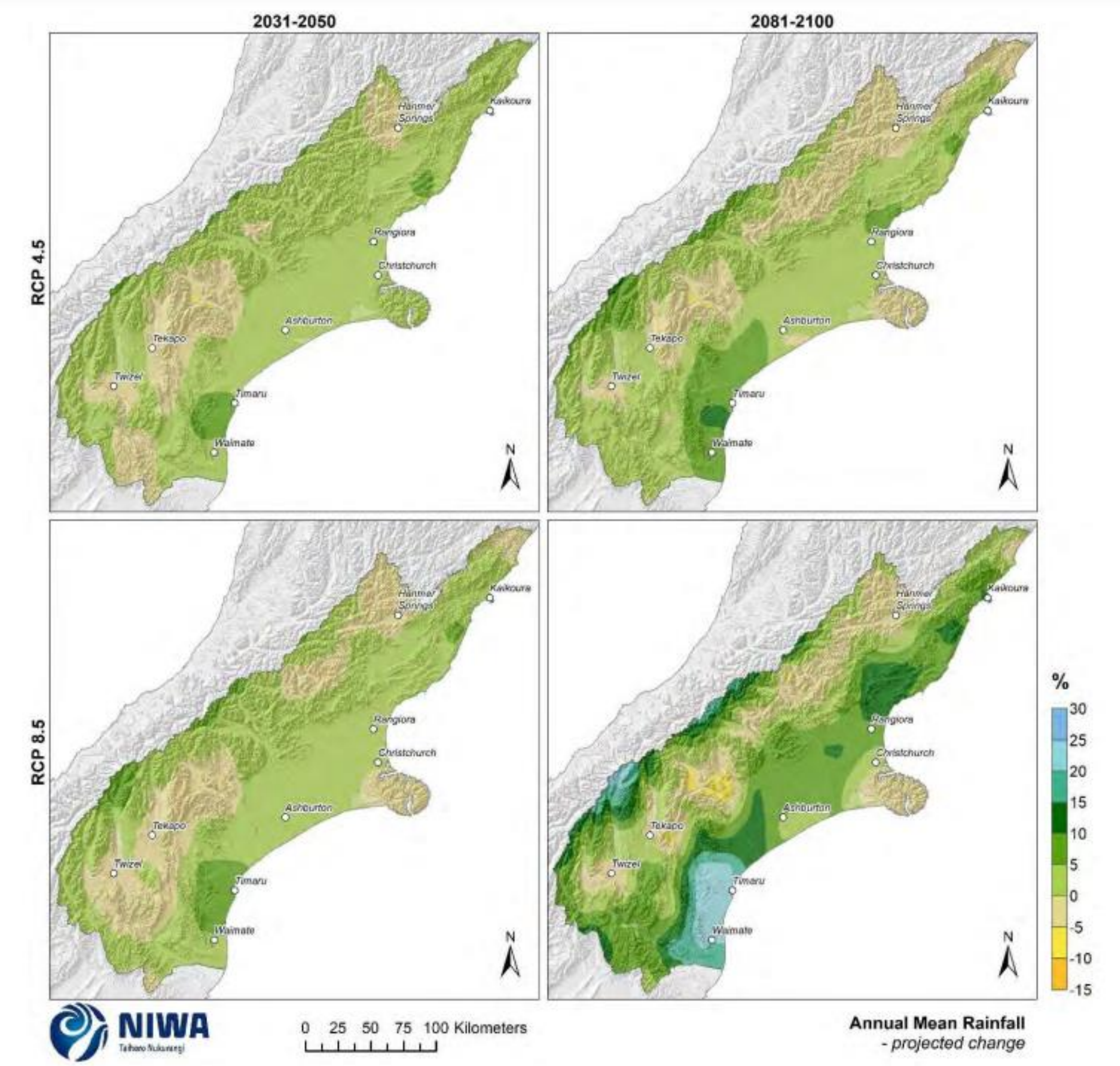
CLIMATE PROJECTIONS



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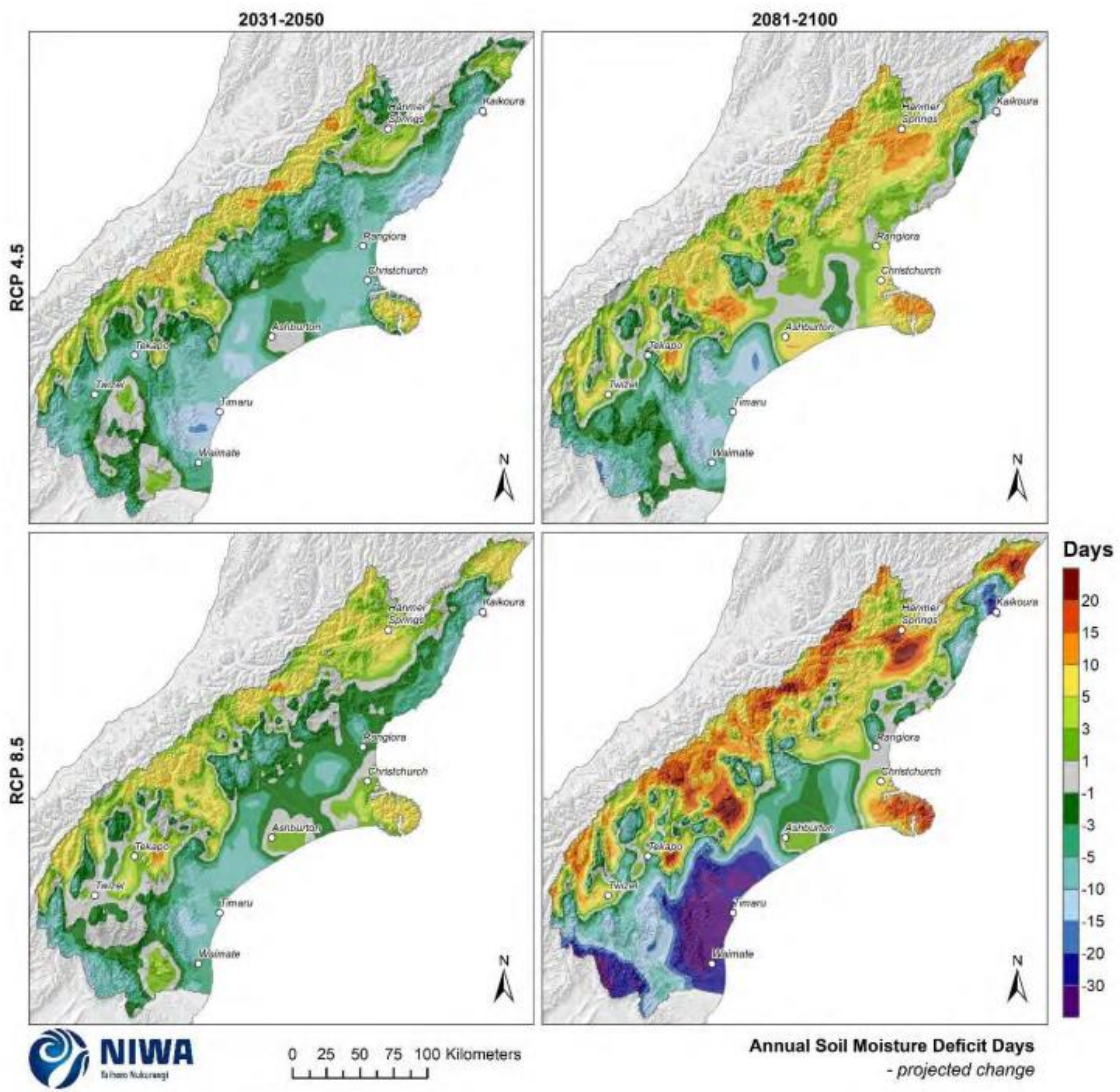


SWEET CORN

Cultivar		Plant to silk		Silk to maturity		Plant to maturity	
		Time (days)	TT_6 (°C days)	Time (days)	TT_6 (°C days)	Time (days)	TT_6 (°C days)
Jubilee	Mean	96	900	52	420	148	1320
	CV(%)	8.3	3.0	19.4	8.6	10.1	3.1
Rival	Mean	95	898	51	424	146	1322
	CV(%)	8.0	3.0	16.9	8.5	10.6	3.9
Reward	Mean	83	817	47	402	130	1215
	CV(%)	2.8	3.7	16.0	6.7	7.6	1.5

- Chronological time and heat units above 6 °C for three sweet corn varieties from planting to maturity;
- Events recorded were planting, silking and maturity.

SWEET CORN

Lincoln

Winchmore

Blenheim

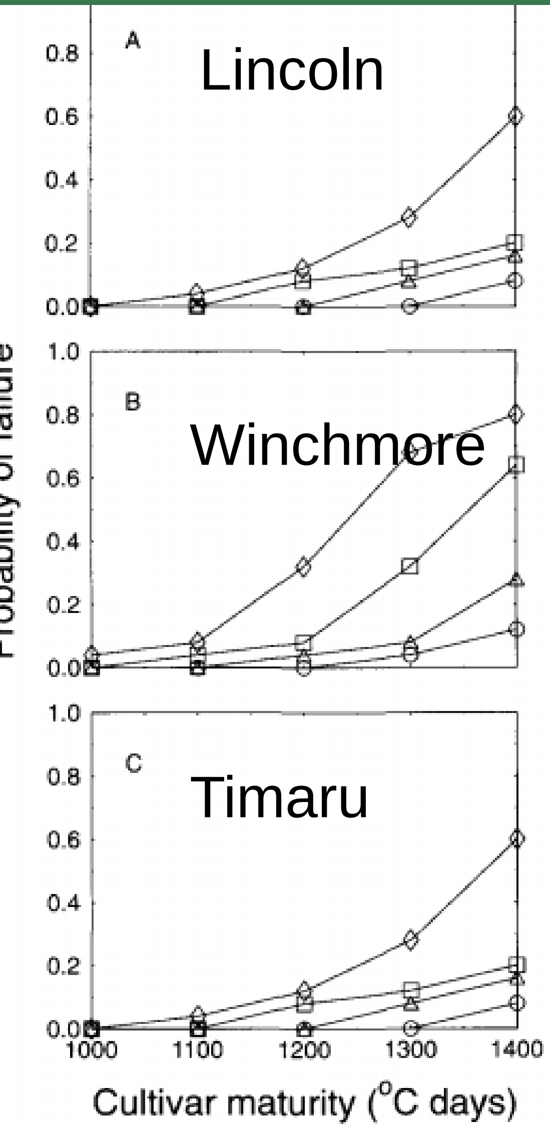
Lincoln

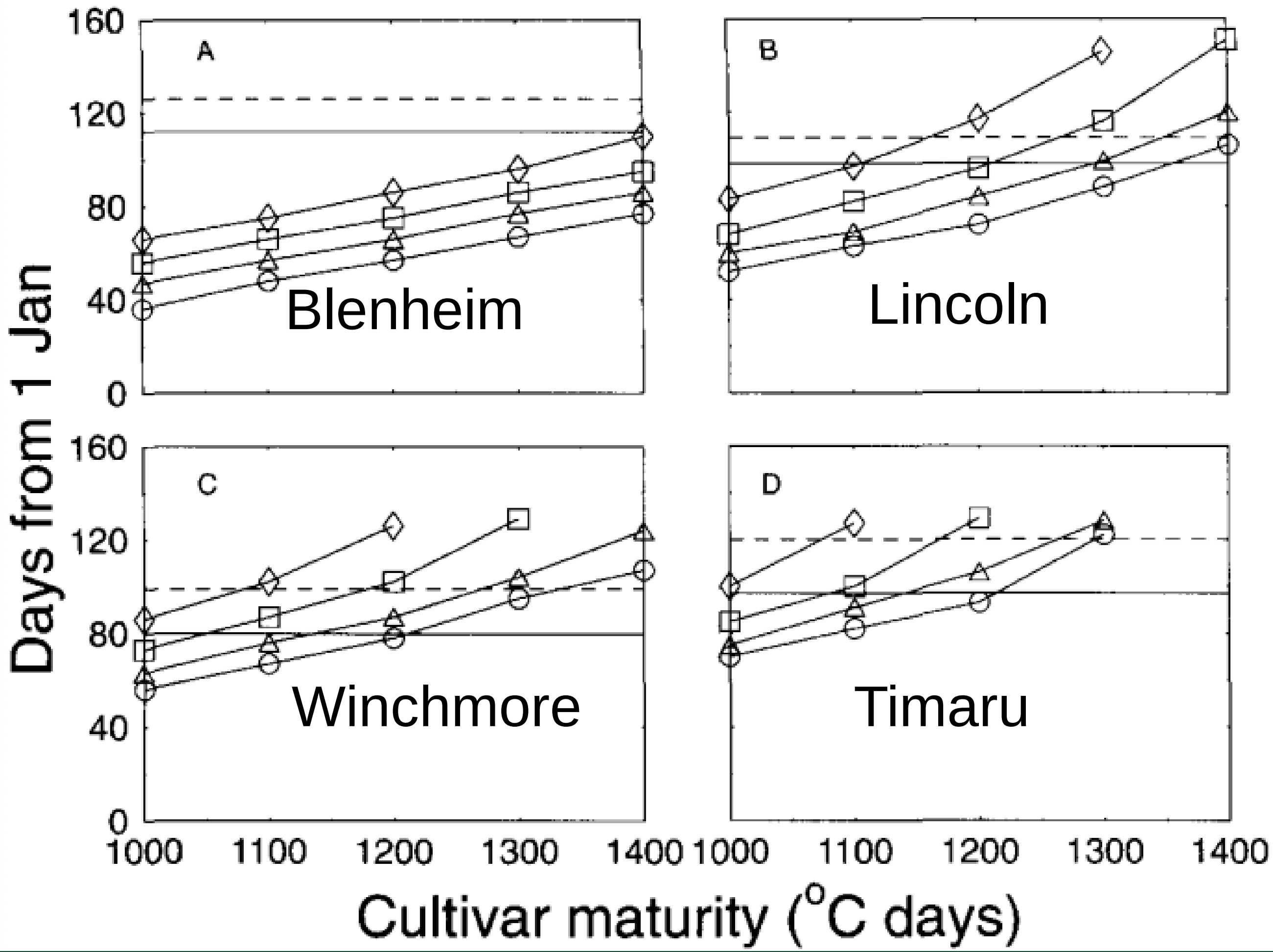
Timaru

Winchmore

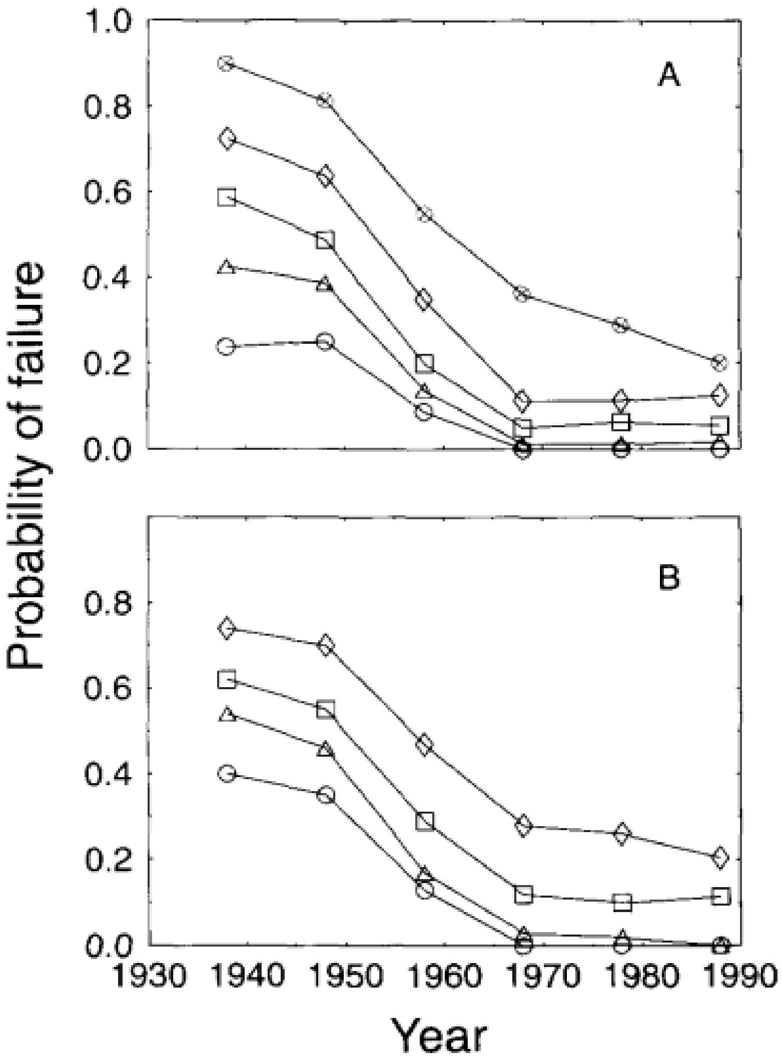
Timaru

SWEET CORN


A
Lincoln
B
Winchmore
C
Timaru
0.0
0.2
0.4
0.6
0.8
1.0
1000
1100
1200
1300
1400
Cultivar maturity (°C days)

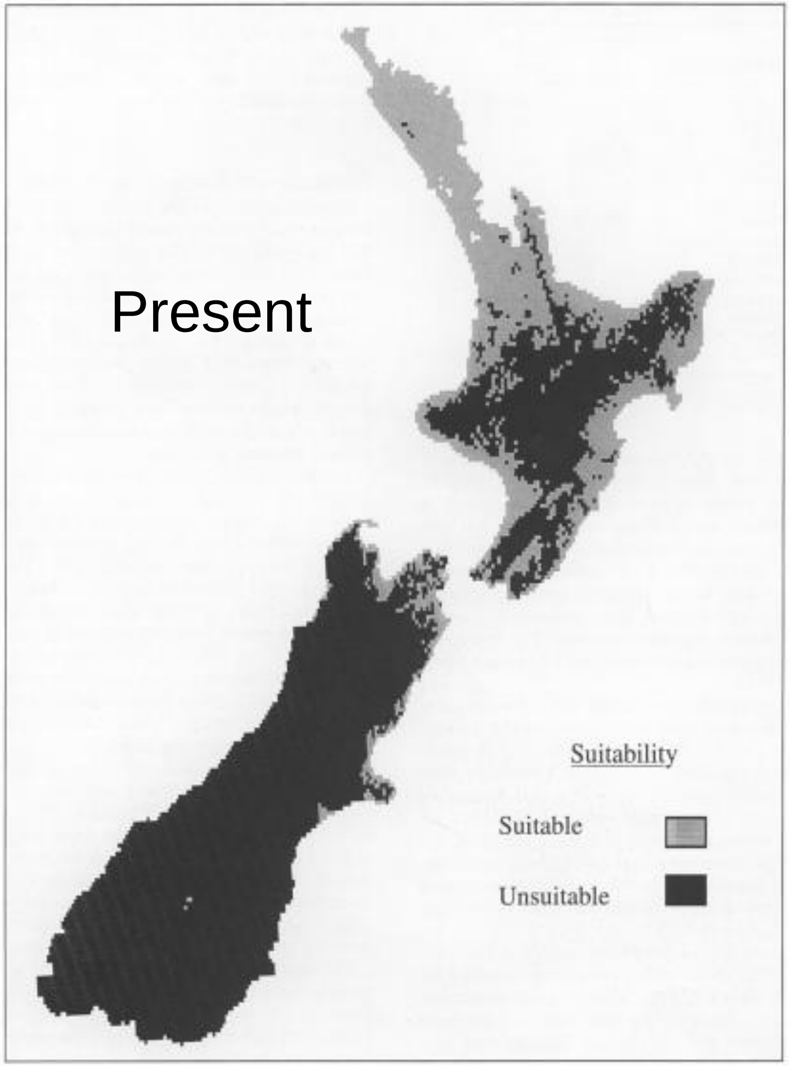

Days from 1 Jan
A
Blenheim
B
Lincoln
C
Winchmore
D
Timaru
0
40
80
120
160
1000
1100
1200
1300
1400
Cultivar maturity (°C days)

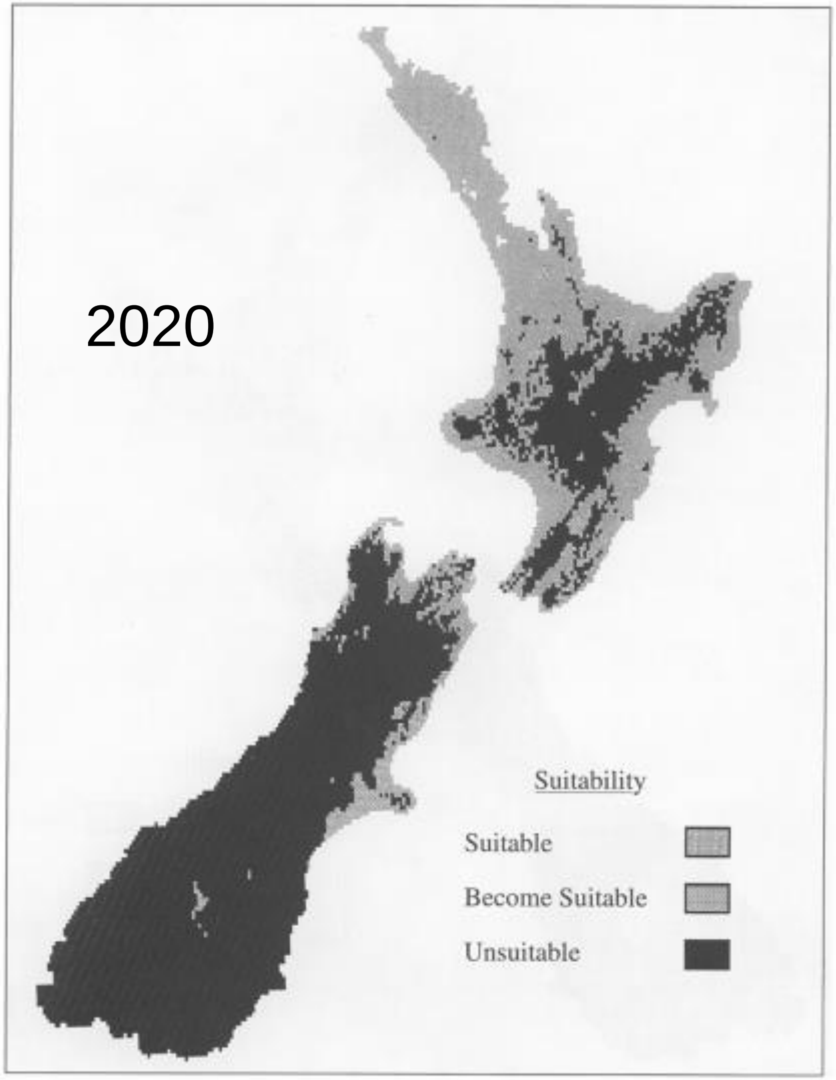
SWEET CORN



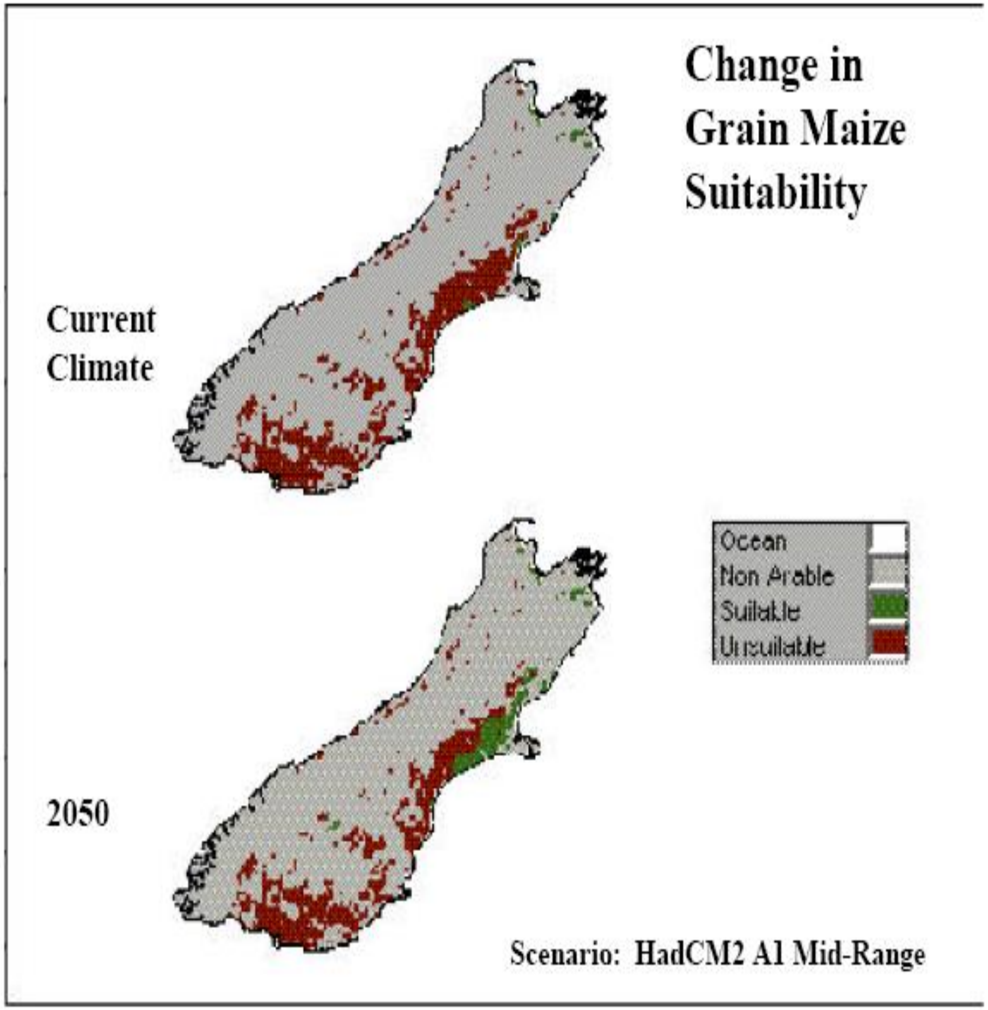
- Sweetcorn production is marginal in the late 20th century Canterbury climate
- Crop failure is likely because of either early frosts or cool seasons
- However recent warming has decreased failure risk
- Warming of 1.5°C will expand the crop range to Canterbury

GRAIN MAIZE


Present
Suitability
Suitable
Unsuitable

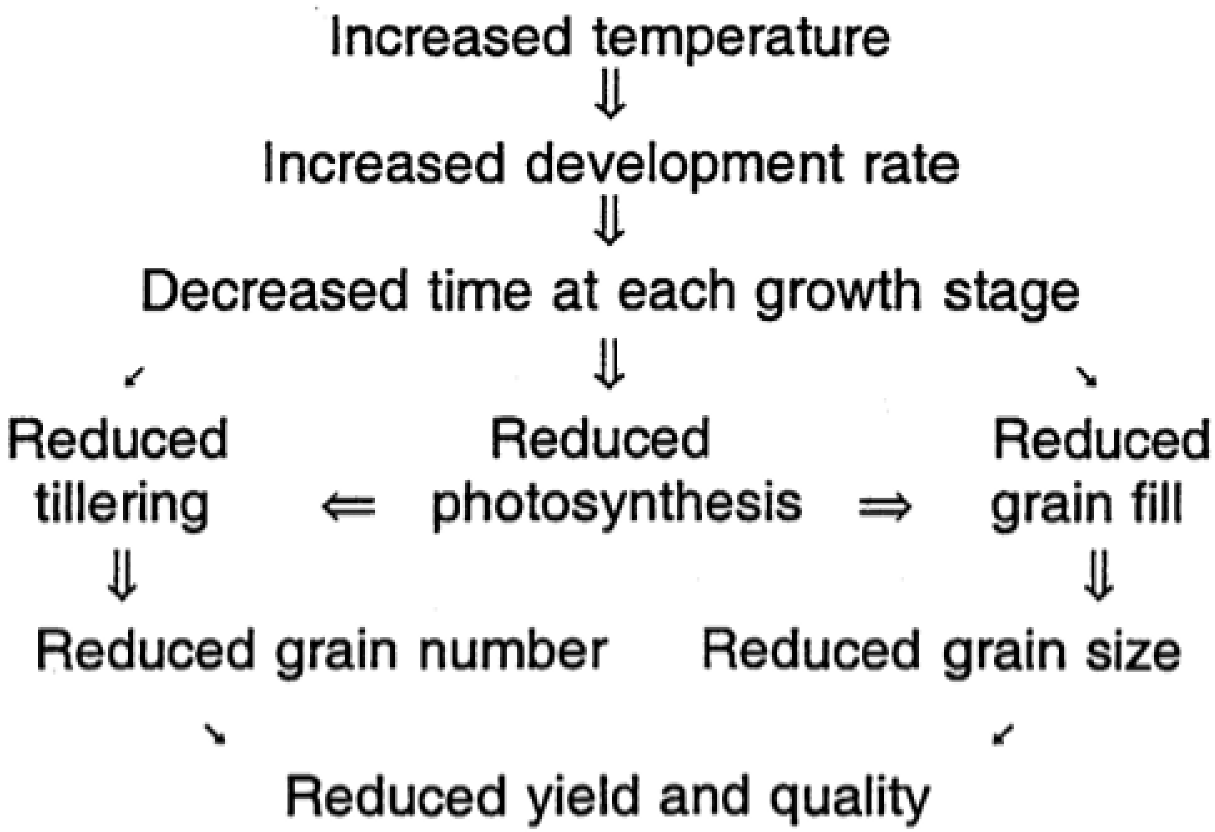

2020
Suitability
Suitable
Become Suitable
Unsuitable

GRAIN MAIZE



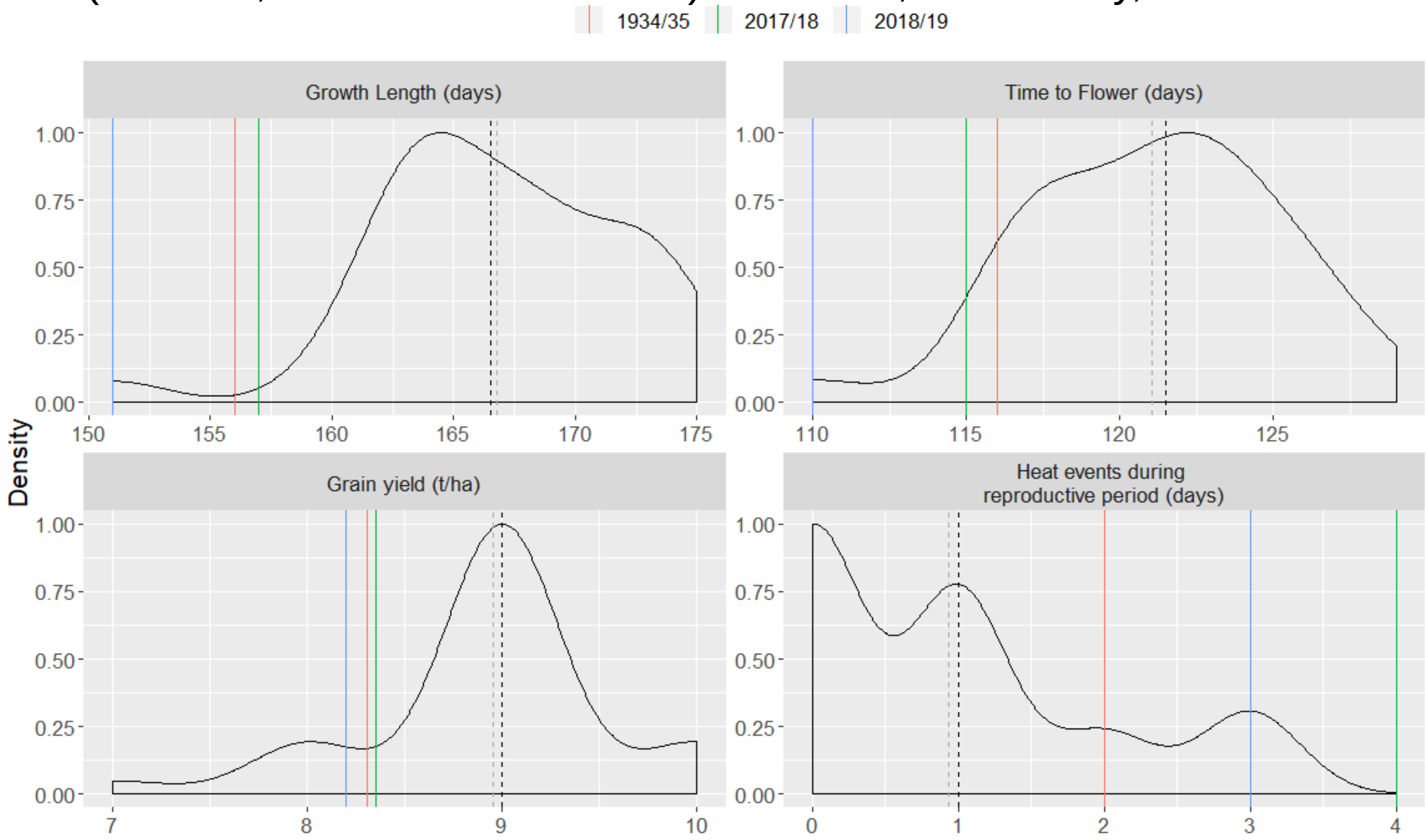
- By a computer-based system (CLIMPACTS) developed for New Zealand that combines models and datasets has enabled integrated assessments of the effects of climate change for crops;
- Locally relevant scenarios of changes in primary climate variables have been produced for New Zealand on a 0.05 ° latitude X 0.05 ° longitude grid;
- The perturbed climate is then used to drive a number of sectoral impact models relevant to New Zealand;
- It is essential to derive crop/climate relationships so as ranges can be mapped.

WHEAT


Increased temperature
Increased development rate
Decreased time at each growth stage
Reduced tillering
Reduced photosynthesis
Reduced grain fill
Reduced grain number
Reduced grain size
Reduced yield and quality

RECENT HEATWAVES

Simulated physiological responses of irrigated spring wheat during three heatwave years (1934/35, 2017/18 and 2018/19) in Lincoln, Canterbury, New Zealand.



Dashed lines are the median (black) and average (dark-grey) of 30 years (1981-2010

FOUR HEATWAVES

- APSIM-wheat simulations showed a reduction in grain yields during heatwave years
- In warm years modeling of wheat yields are reduced by crop development towards early flowering and harvest as crop has less time to convert sunlight into biomass
- 1934/35 and 2017/18 events have estimated return intervals (ERIs) of 40 and 150 years respectively
- Under the 1.5°C warming the ERIs would be 2-3 years. Under 2°C warming, those years would all be **cooler** than average

IMPACTS AND ADAPTATION

- A significant geographical shift in crop production patterns because the range of adaptation of each crop southwards and upwards. This will be necessary to avoid high temperature events that could reduce grain yield and quality;
- In most cases the change will represent an opportunity - the viable range for maize production could move south - a breeding focus on selecting cultivars with adaption to the conditions resulting from climate change;
- Production of newly viable arable crops such as soybeans, rice, quinoa or sorghum will be possible;
- Increased emphasis on the efficient use of water in crop production, especially in traditional eastern grain production areas;
- There is likely to be a higher risk of inadvertent, successful new introductions of weeds, pests and diseases so improved biosecurity will be required;
- The 2017/18 extreme heatwave is a good model of later 21st century climate for arable crops.