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SMART Agri

Agriculture

Projections and interpretation of climate change for the deciduous fruit industry

Prof Stephanie Midgley

Hortgro Technical Symposium, 6 June 2022

We've known about climate change for a long time … (throwback to 2000)

CLIMATE CHANGE IN THE DECIDUOUS FRUIT INDUSTRY: ARE WE IN FOR A ROUGH RIDE?

STEPHANIE WAND

Dept of Horticultural Science
University of Stellenbosch

Cape Pomological Association, 30 May 2000

IPCC established: **1988**
1st Assessment Report: 1990…
…..1995…..2001…..2007…..2013/14…
6th Assessment Report: **2021/22**

CONCLUSIONS

- Climate change is real and will continue.
- Responses by fruit trees will depend on region, cultivar, and the net response to increased temperature (mostly negative) and CO_2 (mostly positive).
- Insufficient chilling and resulting delayed foliation will be exacerbated.
- Fruit quality problems e.g. sunburn and colour loss will increase.
- Other problems (eg marketing) must be overcome if producers are to survive this.

"Twenty-five years ago people could be excused for not knowing much, or doing much, about climate change. Today we have no excuse."

Desmond Tutu, Former Archbishop of Cape Town

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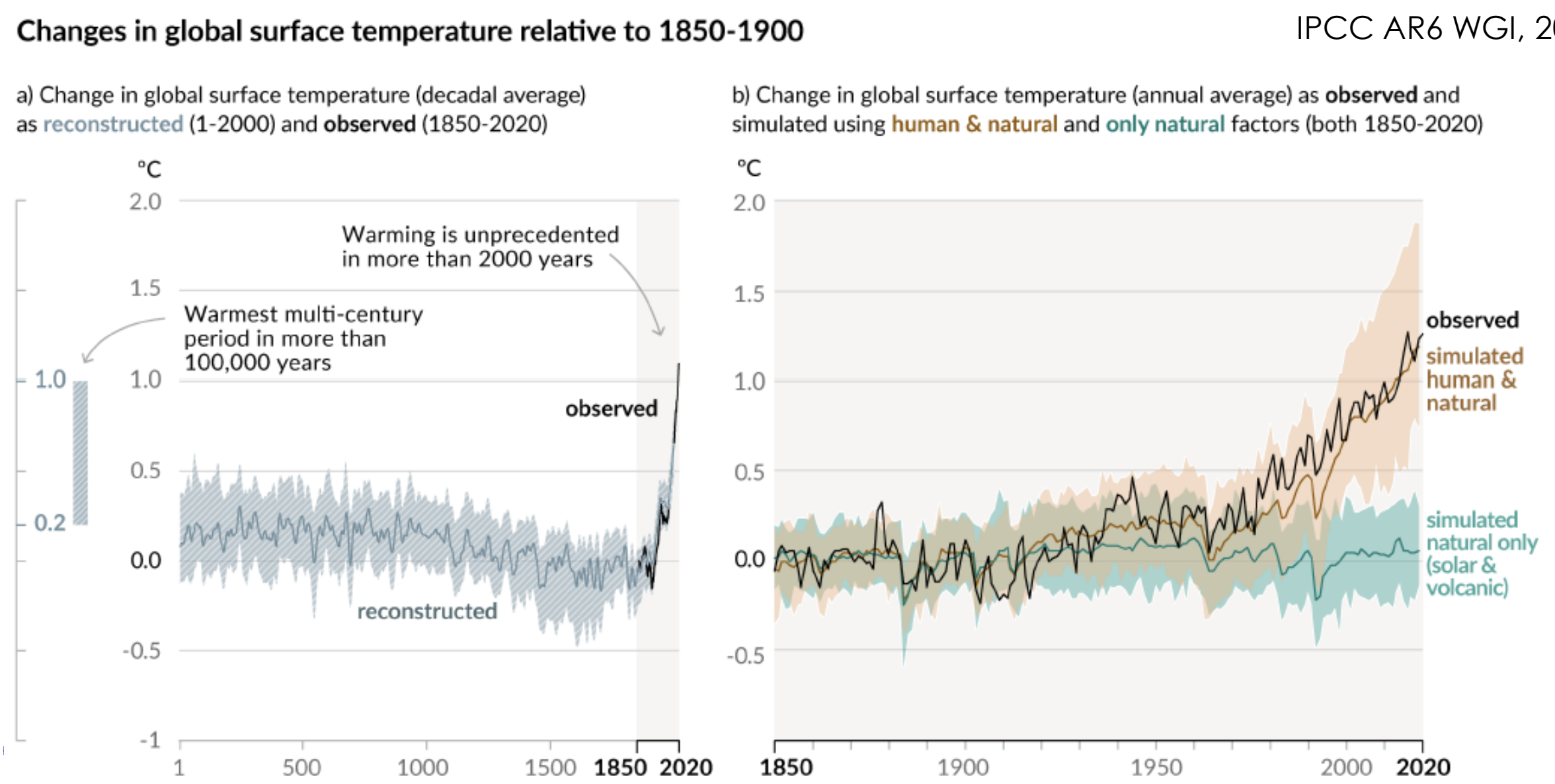
Intergovernmental Panel on Climate Change 6th Assessment Report 2021

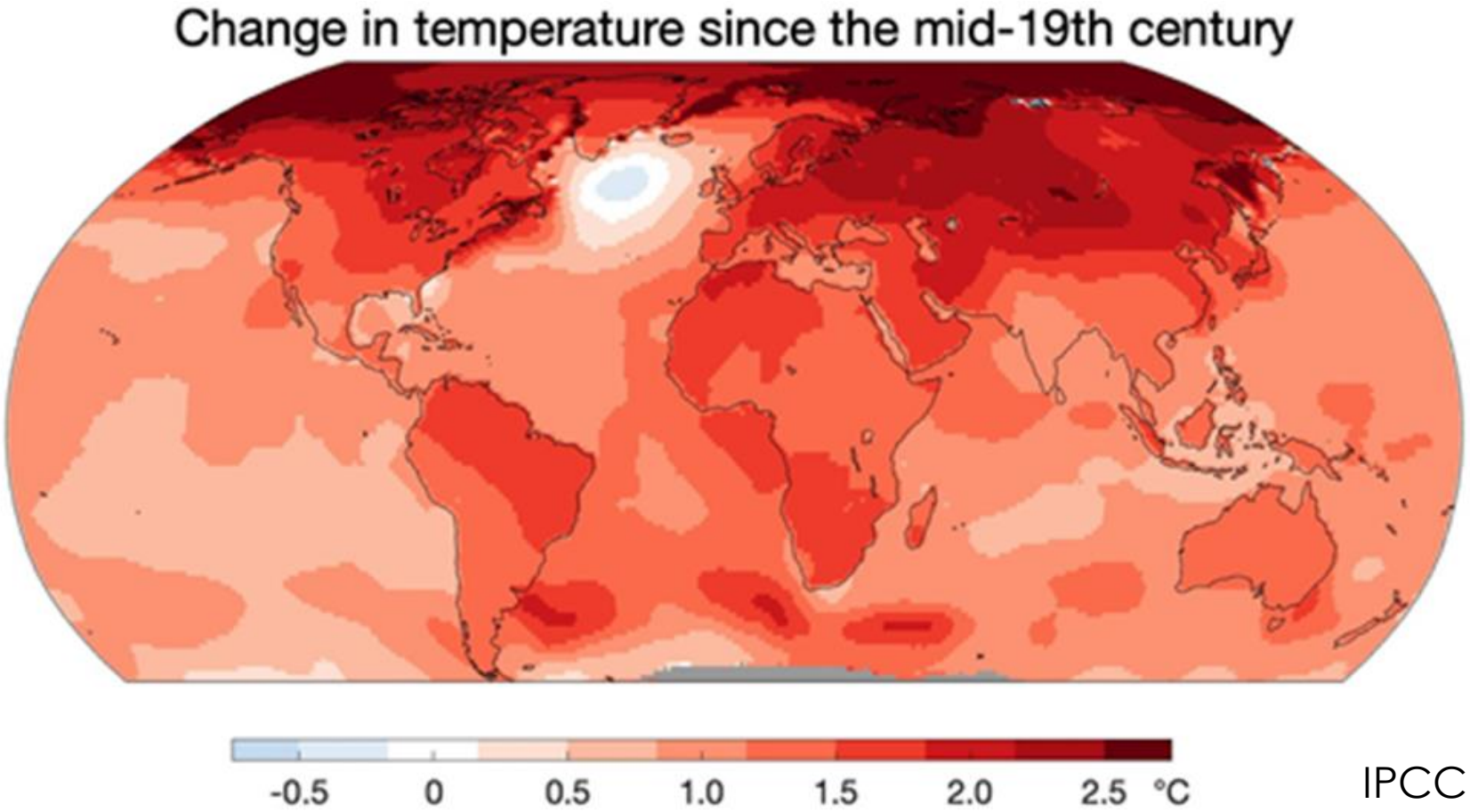
"Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years



The rate of warming is stronger over land than over the ocean

Global surface temperature was 1.09 °C higher in 2011–2020 than 1850–1900, with larger increases over land (1.59 °C) than over the ocean (0.88 °C).



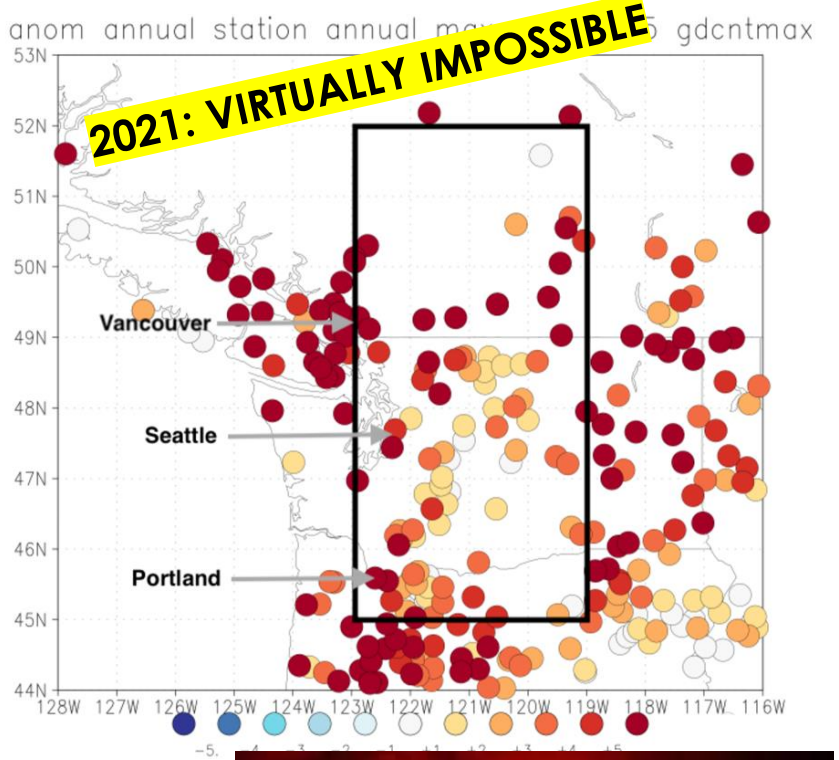
IPCC AR6 WGI, 2021

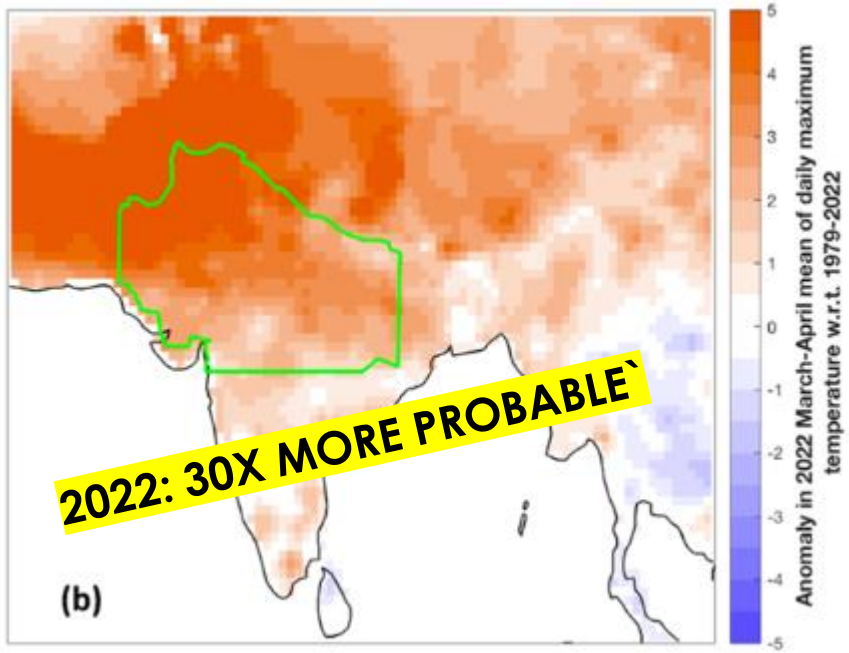
Intergovernmental Panel on Climate Change 6th Assessment Report 2021

[Credit: Yoda Adaman | Unsplash]

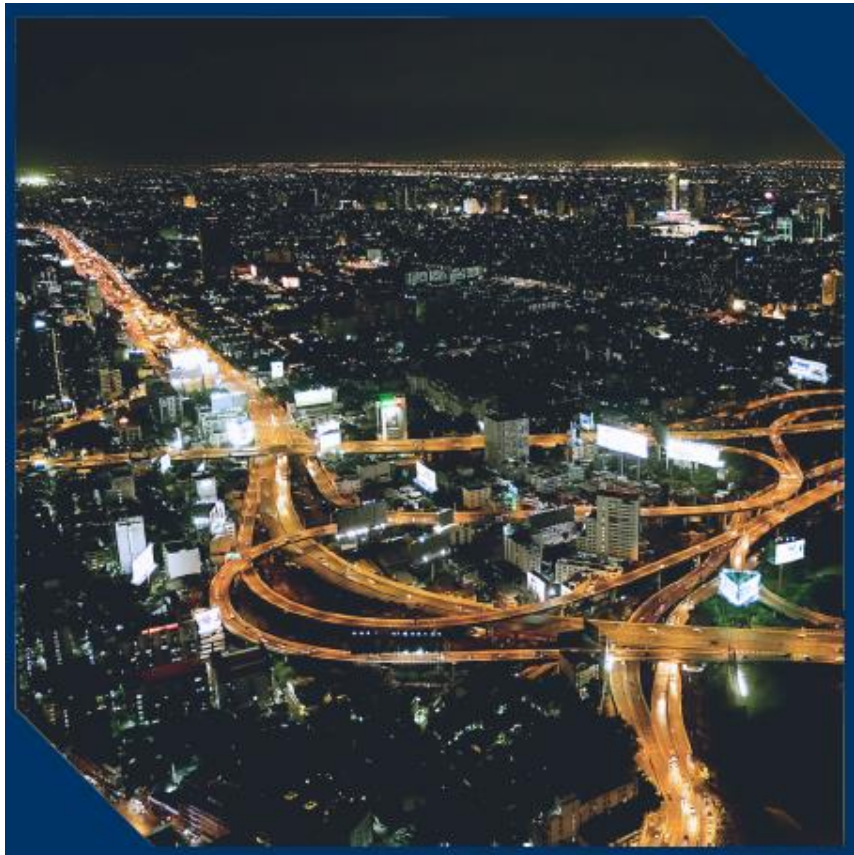
"It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

Climate change is increasing the odds for disasters – THREAT MULTIPLIER





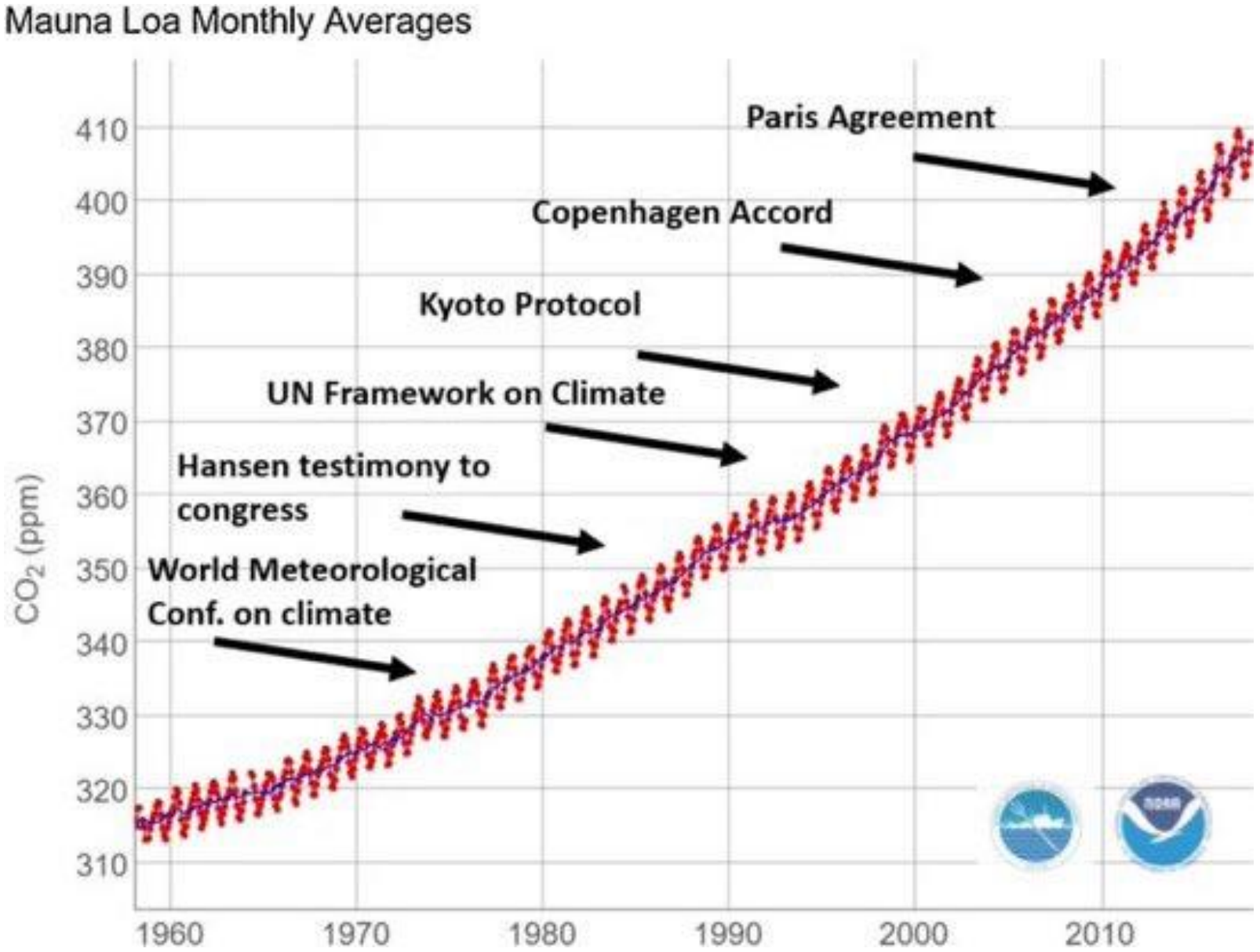
Intergovernmental Panel on Climate Change 6th Assessment Report 2021



[Credit: Peter John Maridable | Unsplash]

"Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.

UNFCC: Global policy responds – but the problem continues

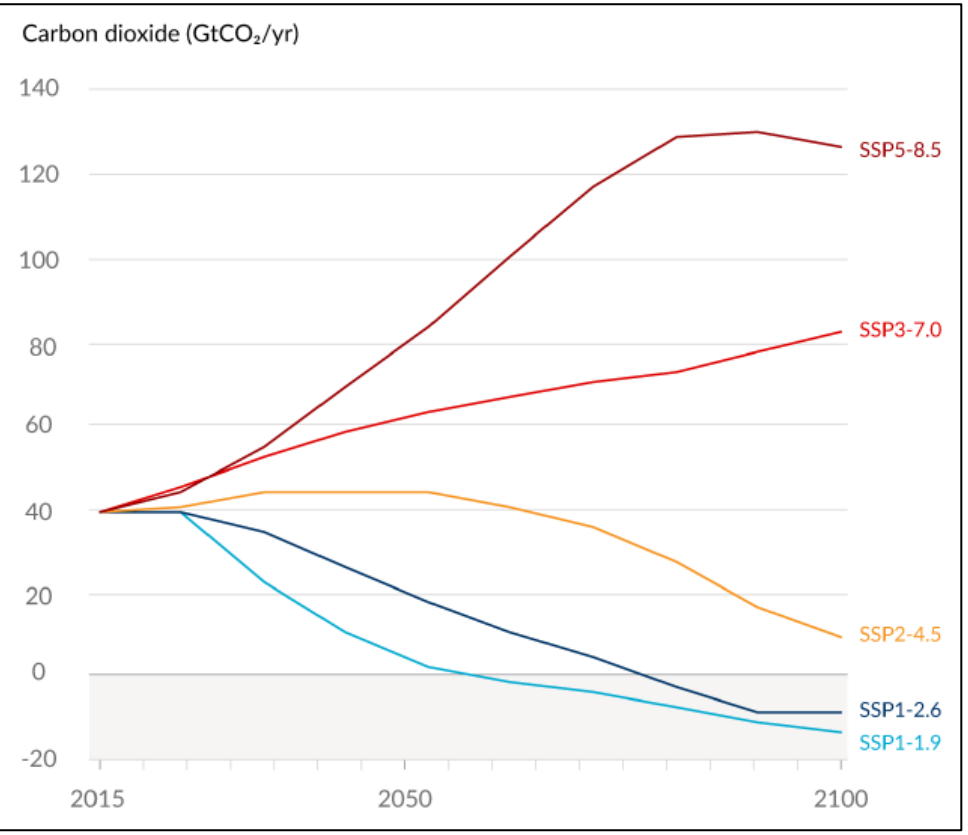


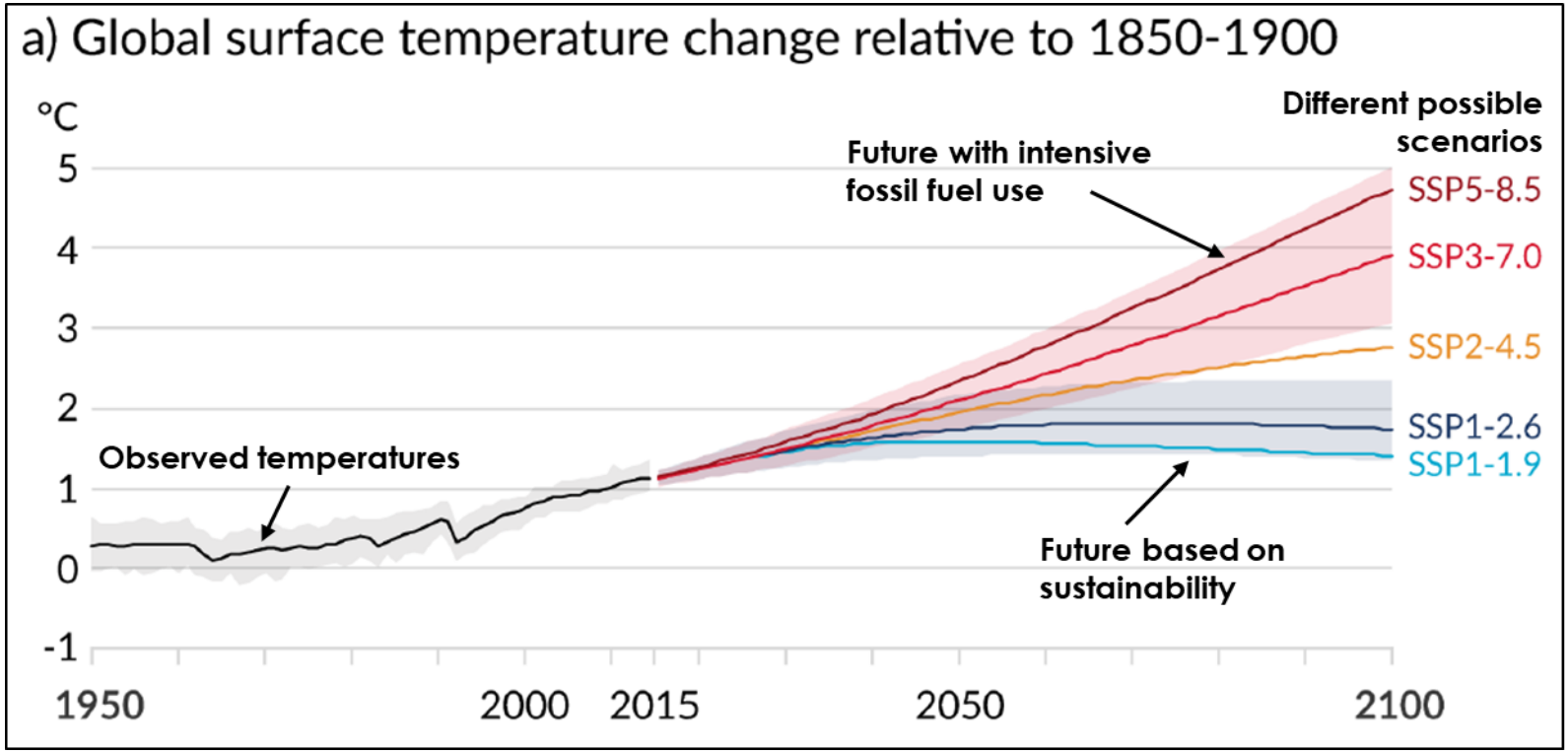
We cannot afford to wait until the **costs of damages** to economies, people and the environment vastly exceed the **costs of solving the problem**

Future emissions cause future additional warming – IPCC scenarios

IPCC (2022): "A scenario is **a plausible description of how the future may develop** based on a coherent and internally consistent set of assumptions about key driving forces and relationships.

Note that **scenarios are neither predictions nor forecasts** but are useful to provide a view of the implications of developments and actions."





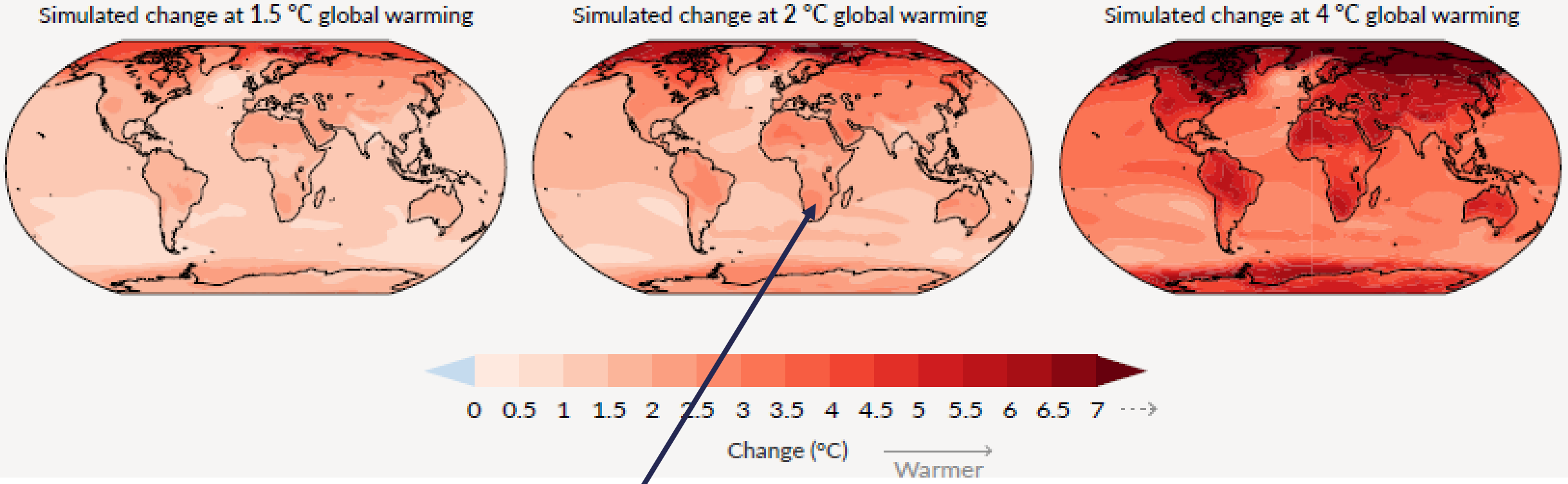
General Circulation Models (GCMs)

- Climate projections are assessed from a range of climate models generically termed GCMs.
- It is **not possible to identify a 'best' model** for all relevant climate variables for South Africa.
- Irrespective of the suite of GCMs used, **future rainfall projections remain challenging** because:
  - Rainfall is a derived rather than a direct output from GCMs;
  - Complex rainfall-generating processes such as cloud formation and land surface-atmosphere interactions are not yet fully understood and resolved in climate models;
  - Rainfall is an event-based variable, and not continuous, as is temperature.
- **Timescales:**
  - Historical climate data;
  - Immediate (short term) future (until 2030s);
  - Intermediate future (2046-2065);
  - End-century (2080-2100).

With every increment of global warming, changes get larger in regional mean temperature

b) Annual mean temperature change (°C) relative to 1850-1900

Across warming levels, land areas warm more than oceans, and the Arctic and Antarctica warm more than the tropics.



Warming in SA > 2.5 °C when global warming increase is 2 °C

IPCC AR6 WGI, 2021

With every increment of global warming, changes get larger in regional mean precipitation

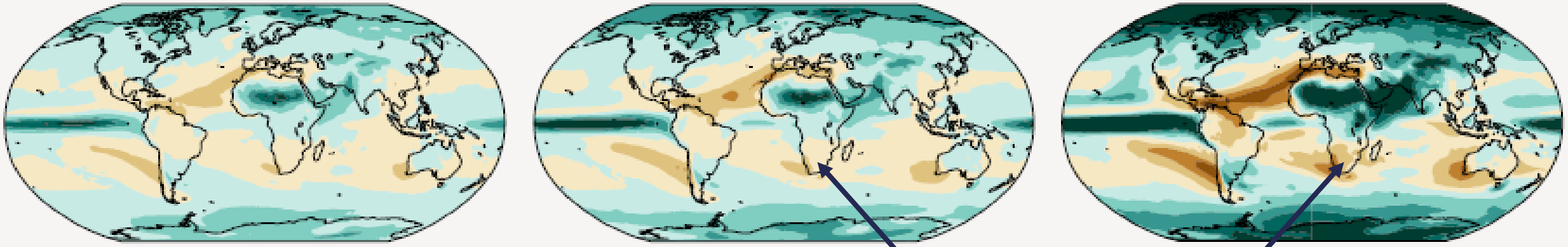
c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

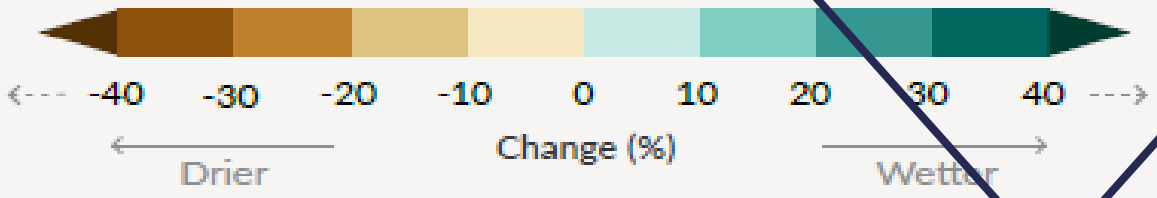
Simulated change at 1.5 °C global warming

Simulated change at 2 °C global warming

Simulated change at 4 °C global warming



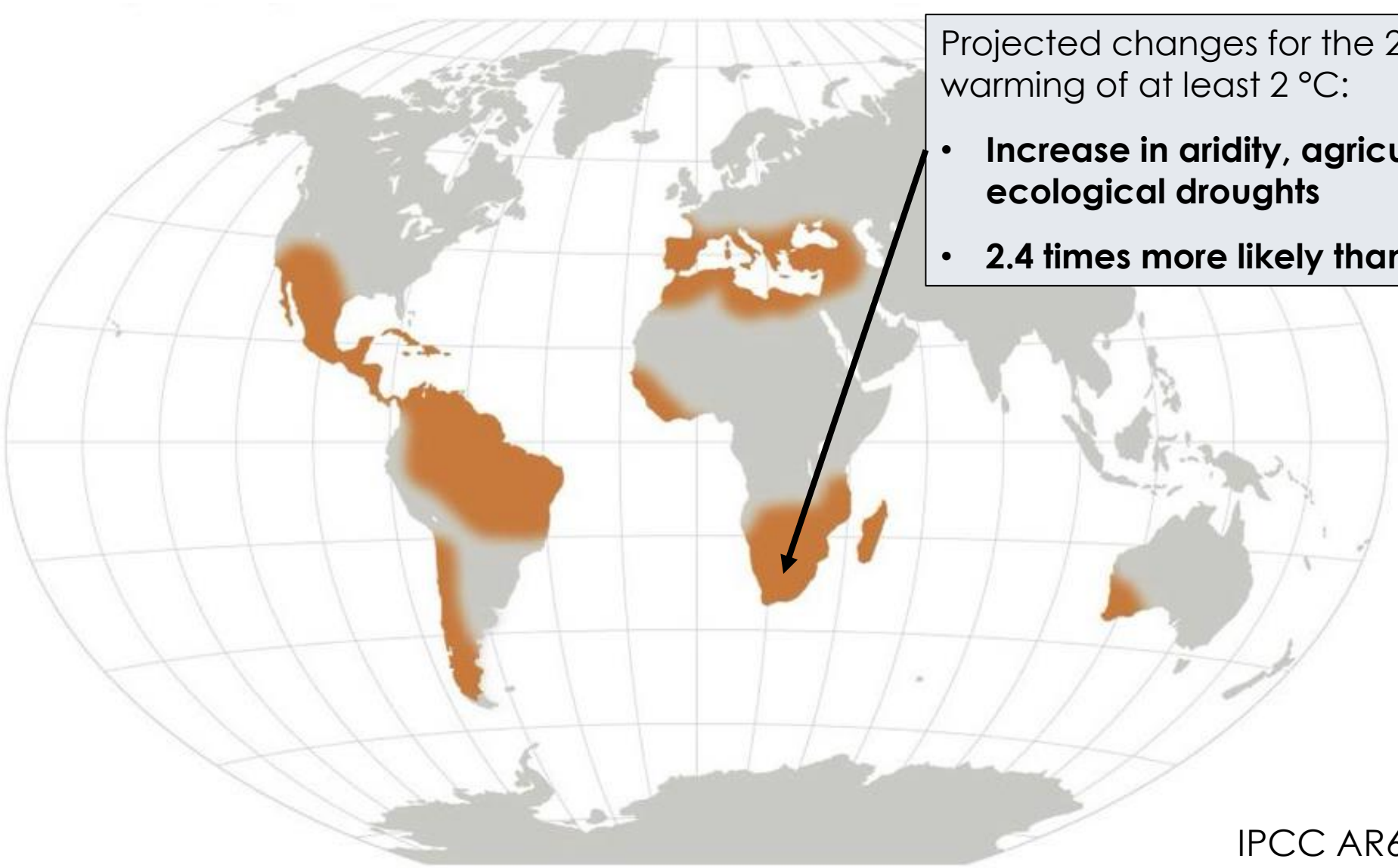
Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions



Precipitation is projected to **decrease** over parts of the subtropics, and Mediterranean climates.

IPCC AR6 WGI, 2021

Drought is expected to increase under future warming in some regions

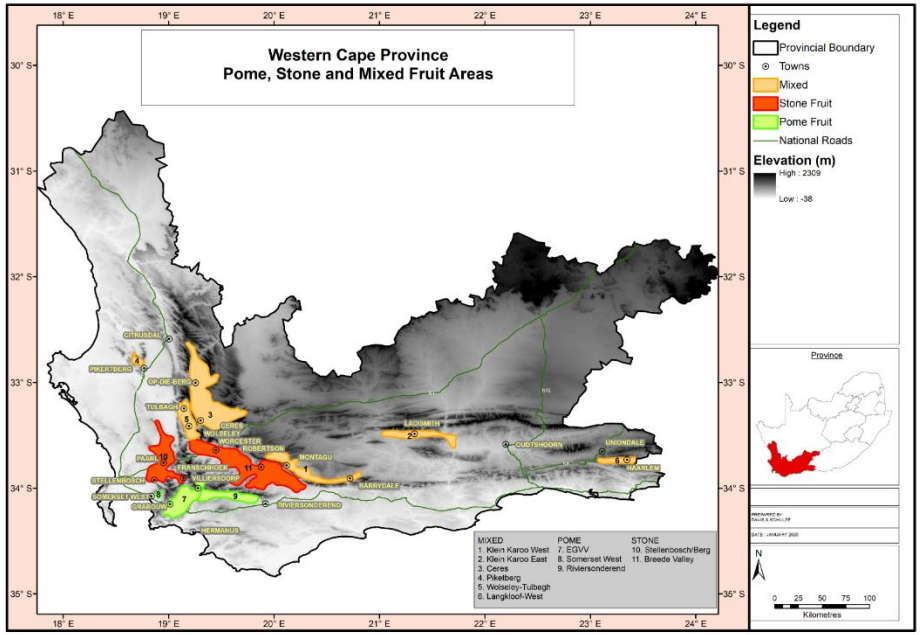


Projected changes for the 2050s with warming of at least 2 °C:

- **Increase in aridity, agricultural and ecological droughts**
- **2.4 times more likely than in 1850-1900**

IPCC AR6 WGI, 2021

Climate change modelling/mapping for Western Cape and Hortgro

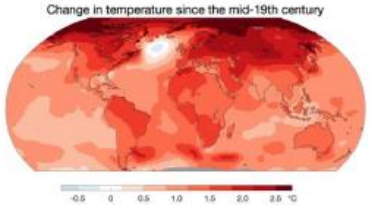


HORTGRO
Growing Fruit IQ

Scientific and Practical Guide to Climate Change and Pome/Stone Fruit Production in South Africa

Extended Executive Summary

April 2021



Isikhungusethu Environmental Services (Pty) Ltd

Schulze & Associates

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CLIMATE SYSTEM ANALYSIS GROUP CSAG

SmartAgri: Climate Change Status Quo Update 2021

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Compiled by Christopher Jack
Data management, analysis and written contributions by Lisa Van Aardenne, Piotr Wolski, Izidine Pinto, Kwesi Quagraine and Pierre Kloppers

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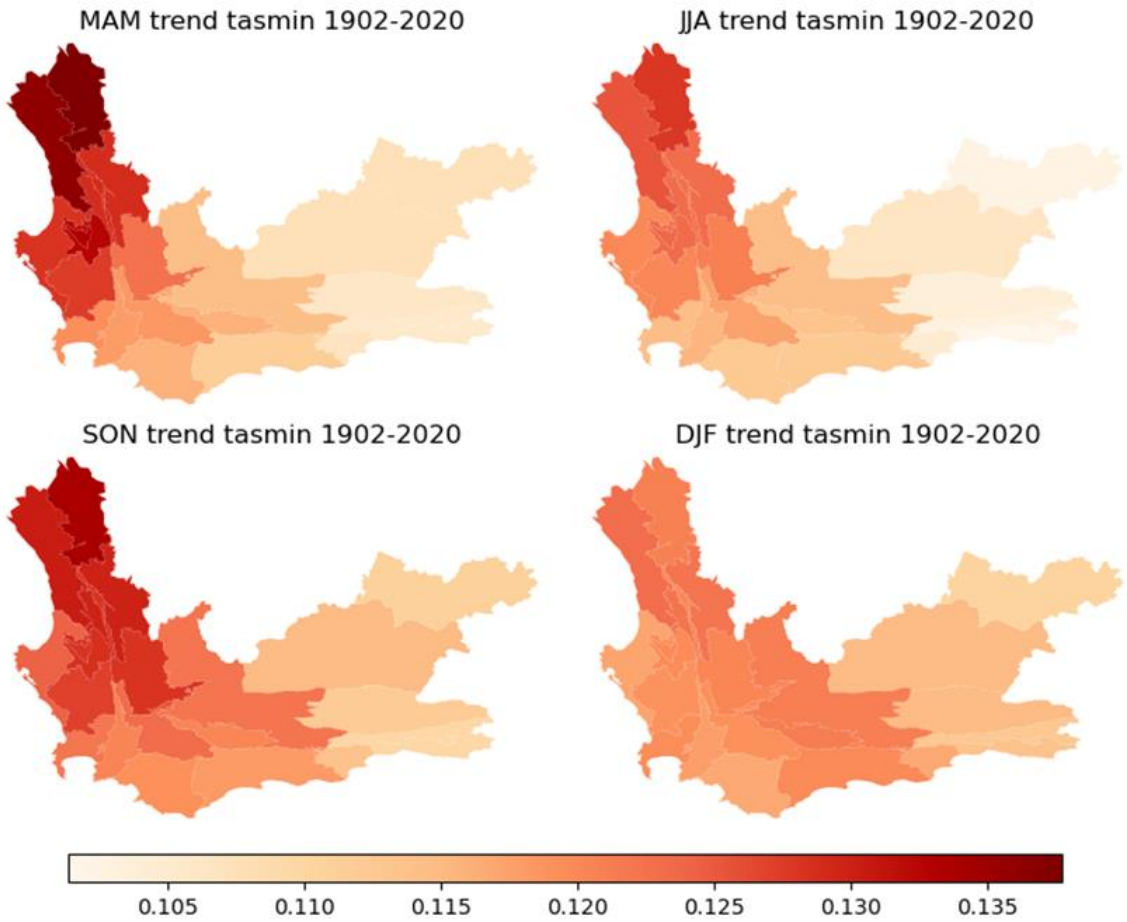
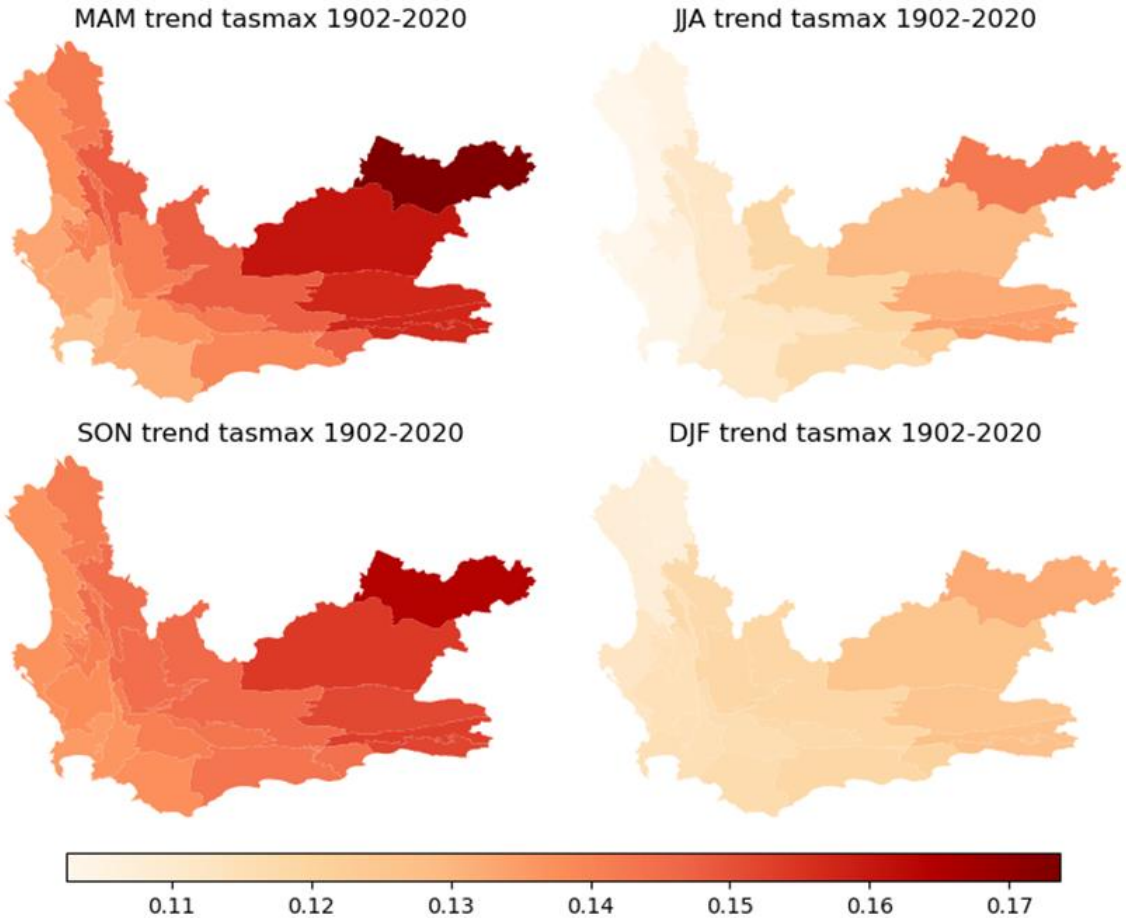
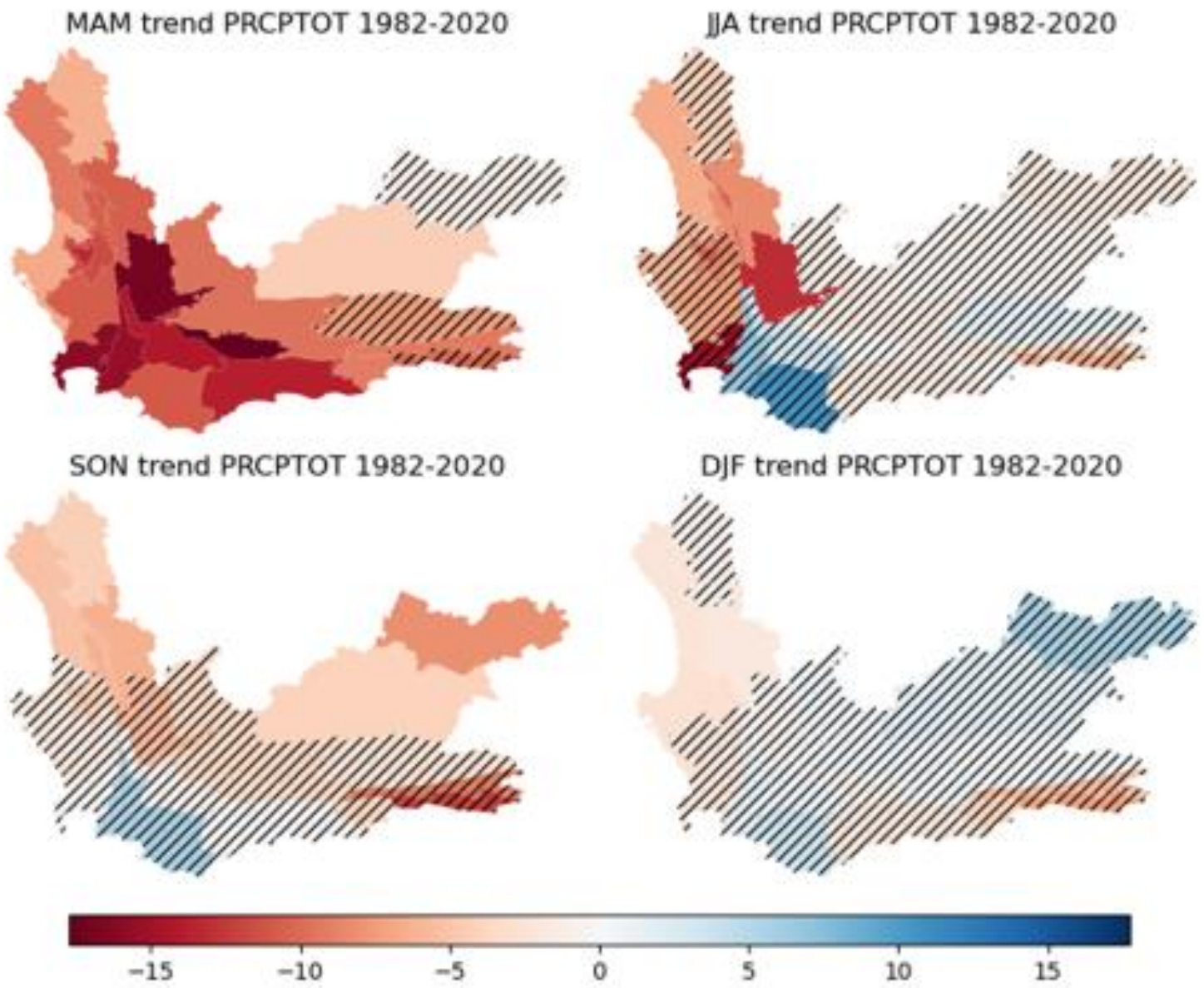
Trend in seasonal daily min/max temperature (°C/decade): 1902-2020





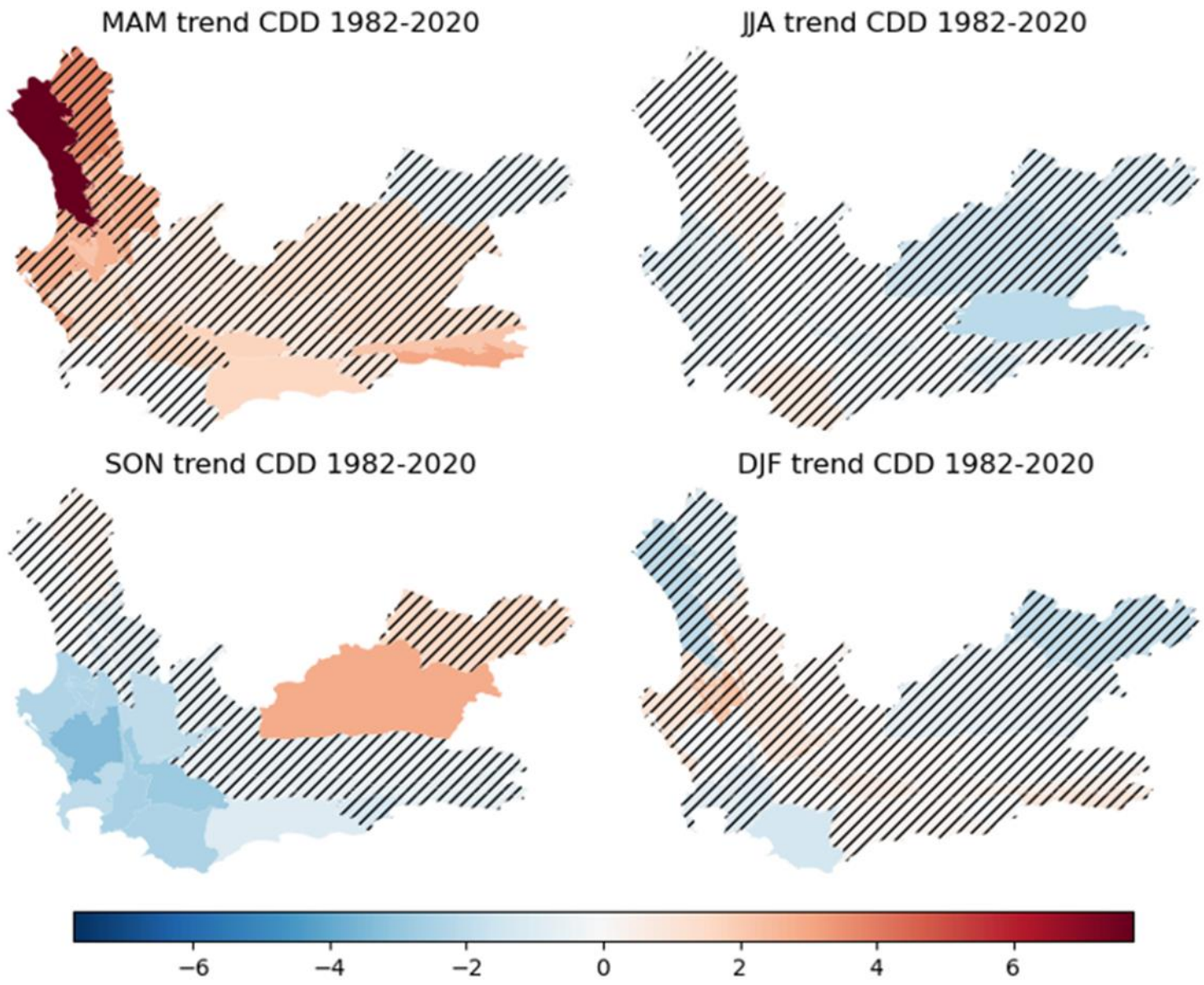
CSAG (2022)

Trend in seasonal rainfall (mm/decade): 1982-2020



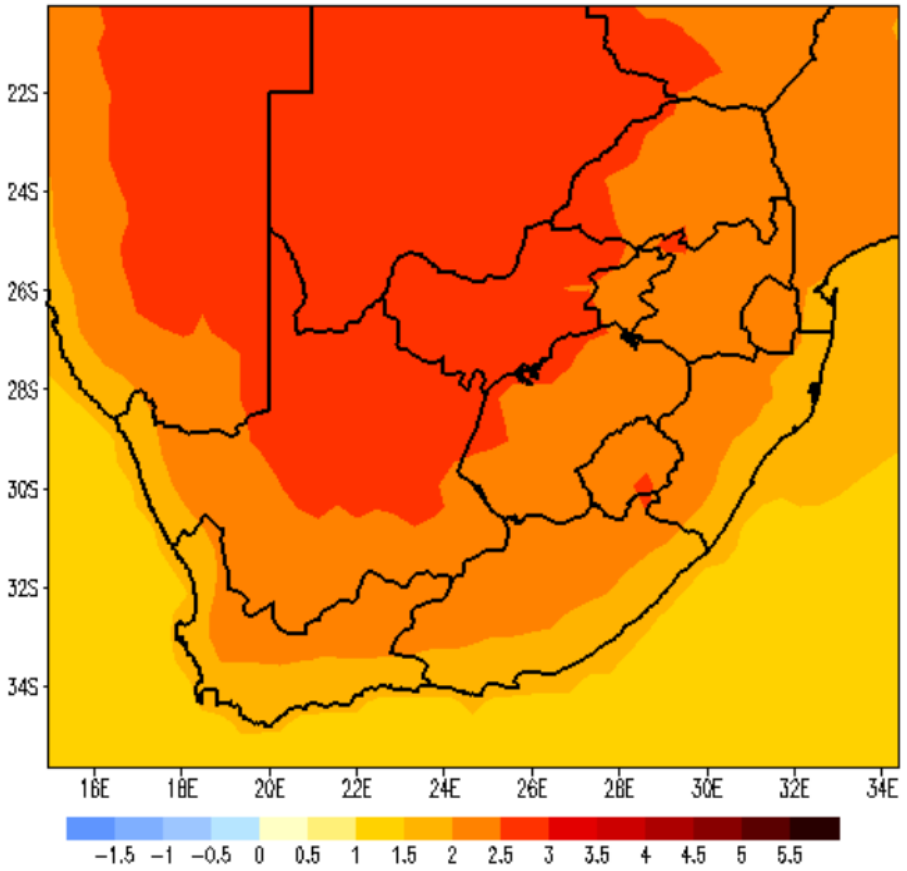
CSAG (2022)

Trend in seasonal maximum consecutive dry days (days/decade): 1982-2020

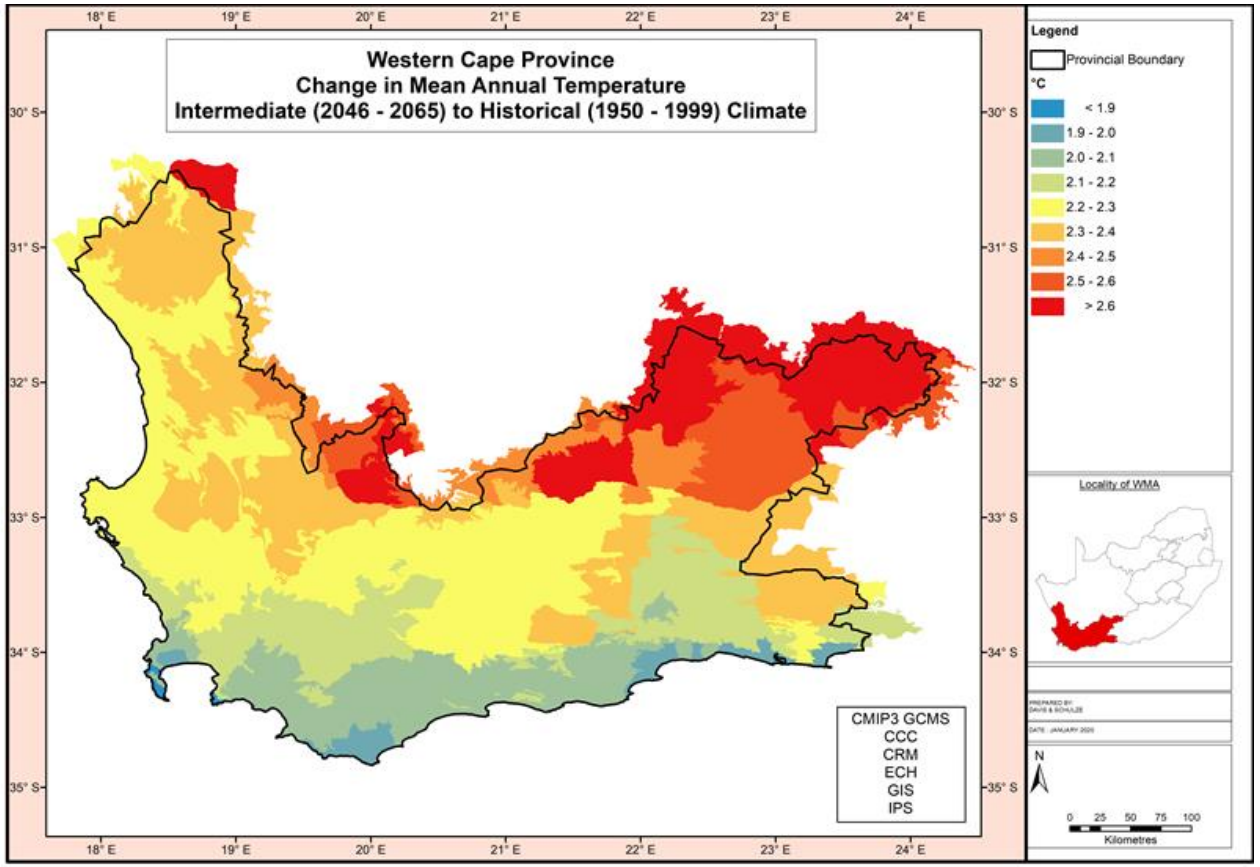


CSAG (2022)

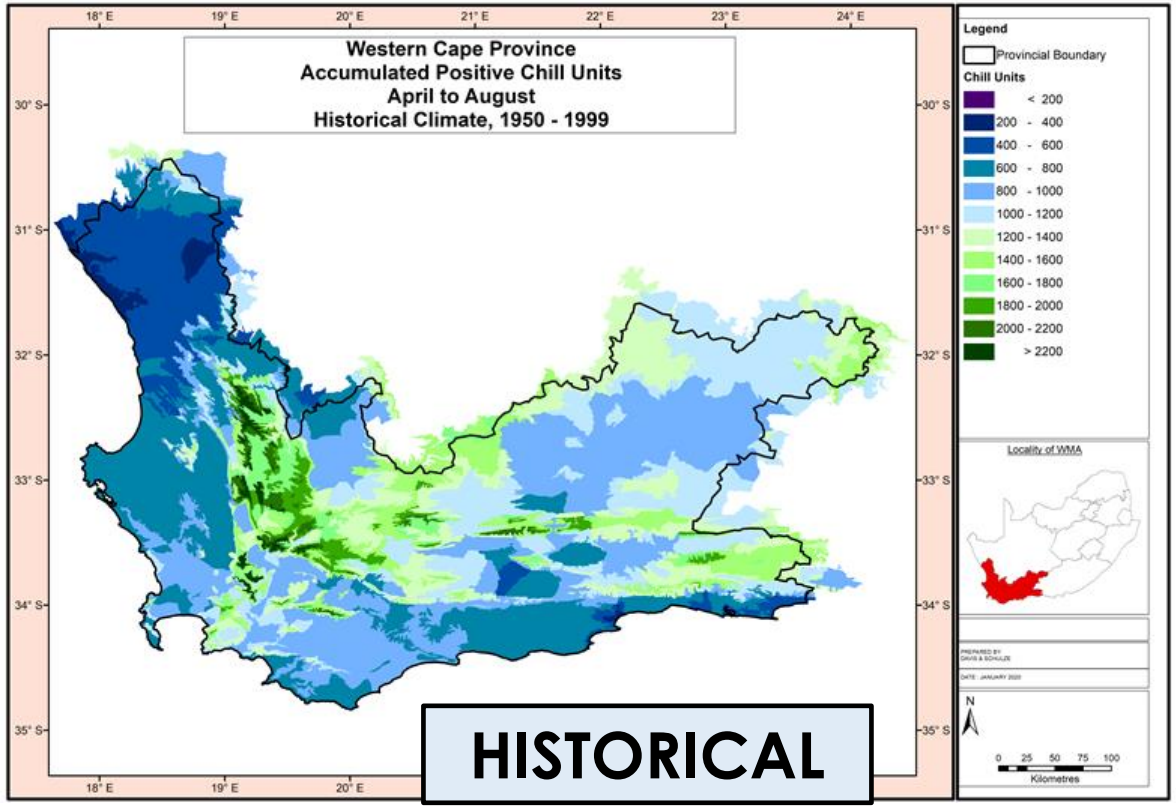
Change in future Mean Annual Temperature

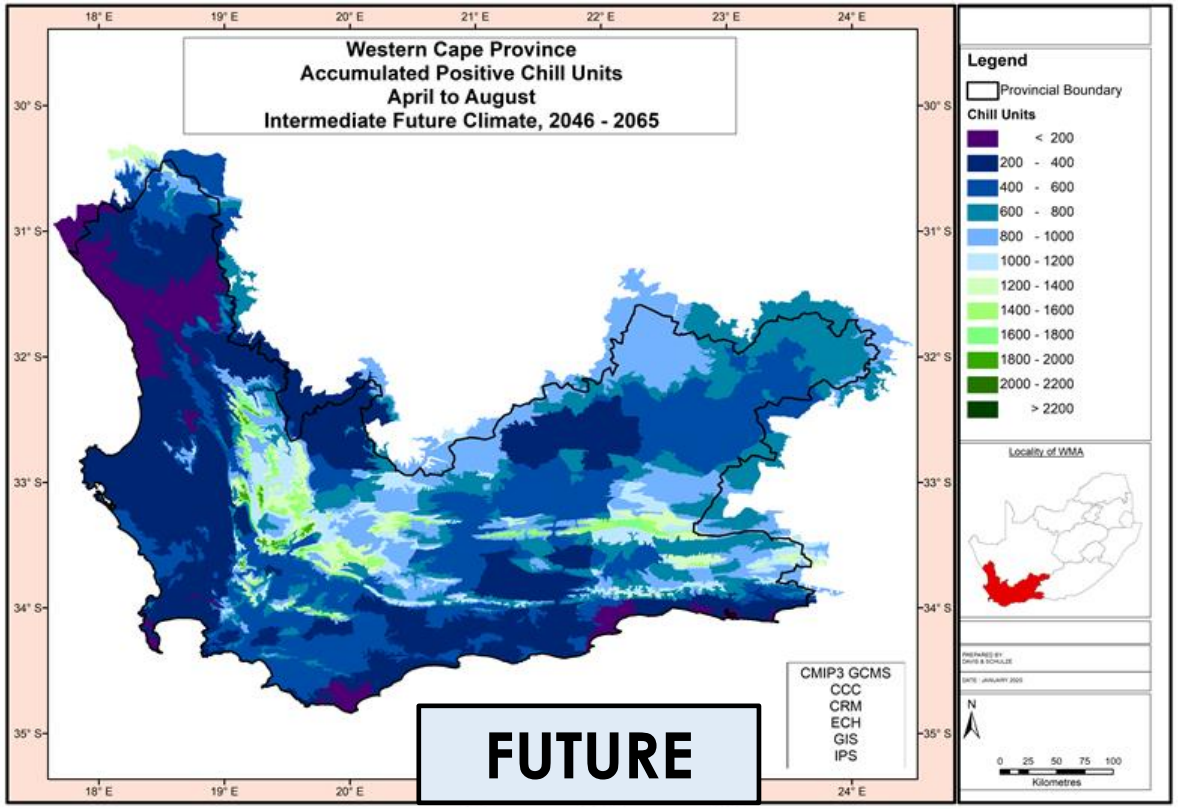


Multi-model ensemble projections



Accumulated seasonal chill units – April to August ~ 2050





Historical period:
Pome fruit regions: 800 – 2000 PCUs
Stone fruit regions: 600 – 800 PCUs also common

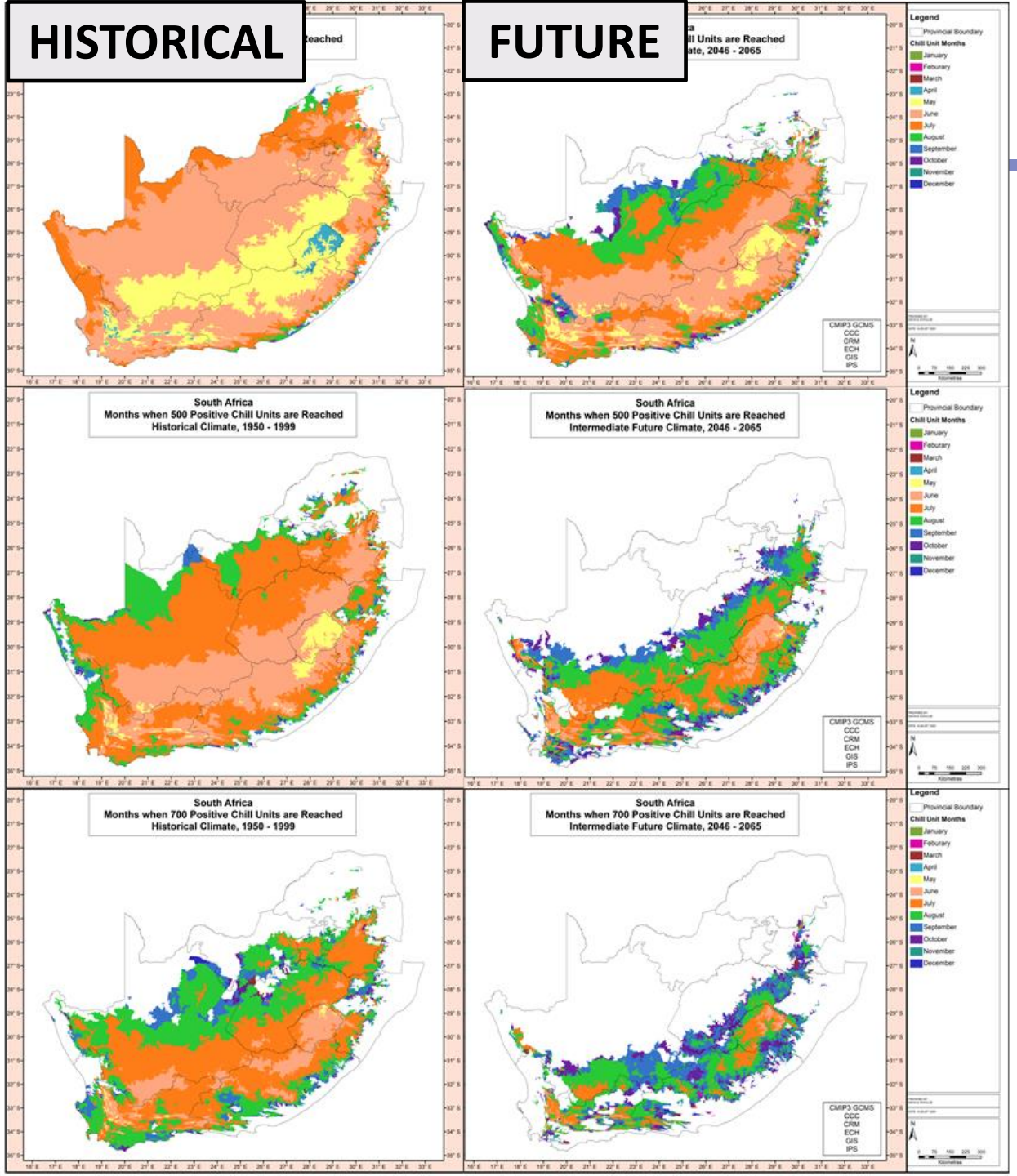
Intermediate future: Reductions of 250-500 PCUs
Pome fruit regions: 200 - 1600 PCUs
Stone fruit regions: 200 - 600 PCUs also common

Month to reach 250, 500 and 700 chill units: ~2050

250 PCUs

500 PCUs

700 PCUs



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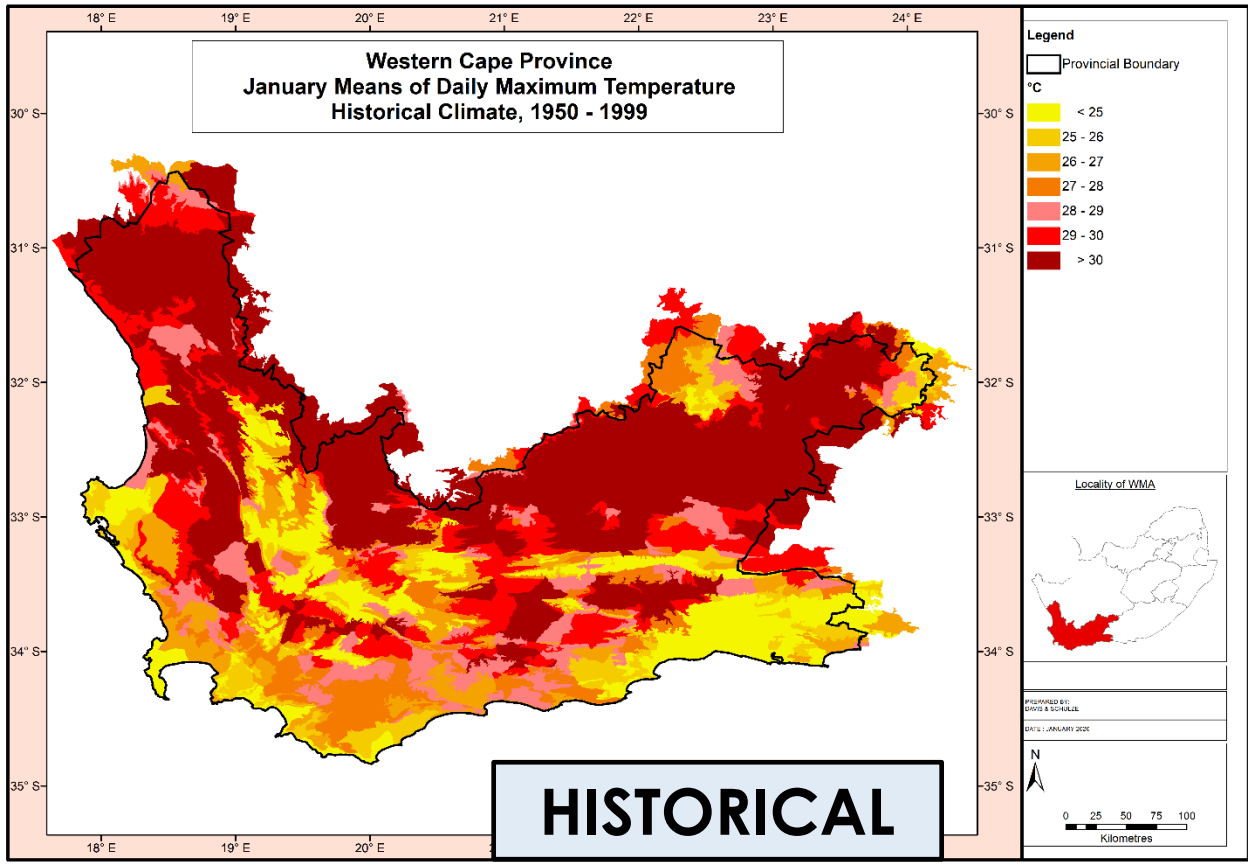
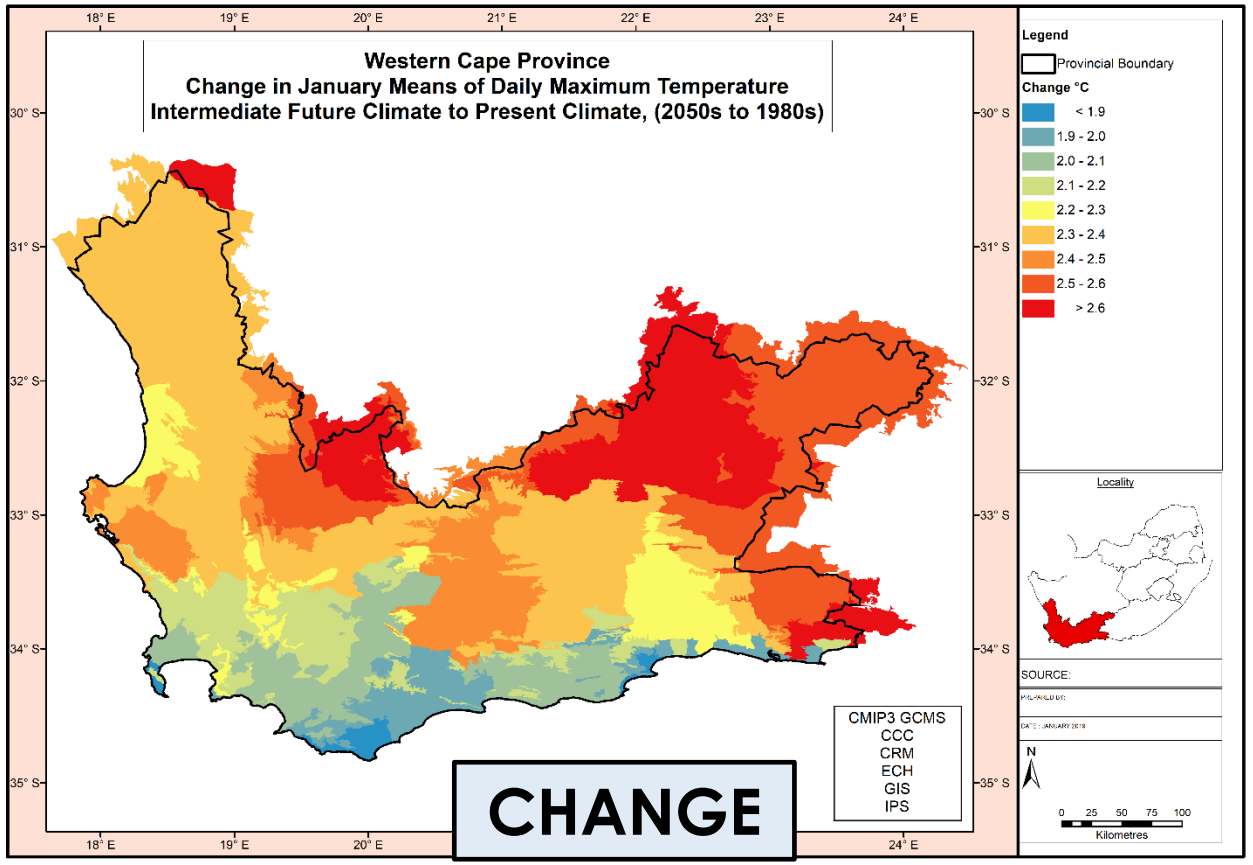
High temperature stress – daily T_{max} in January ~ 2050

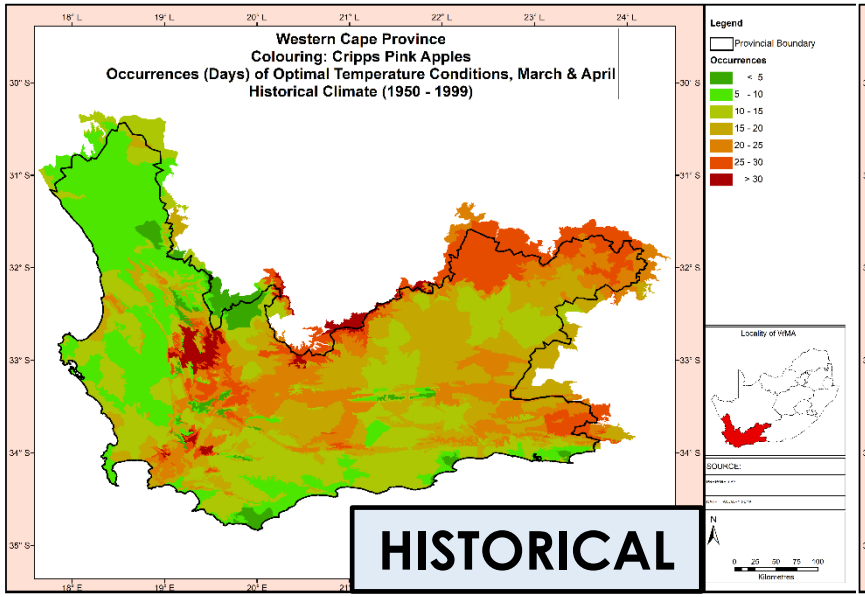


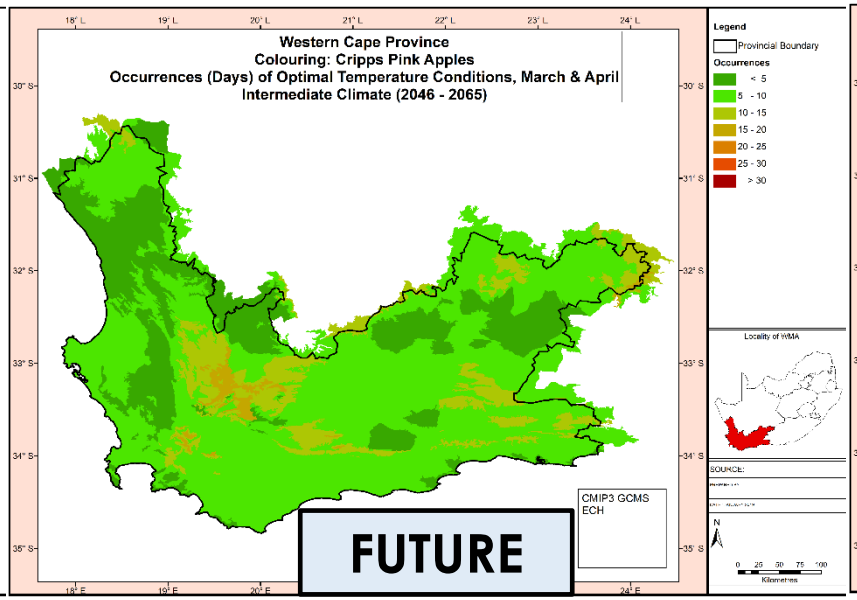


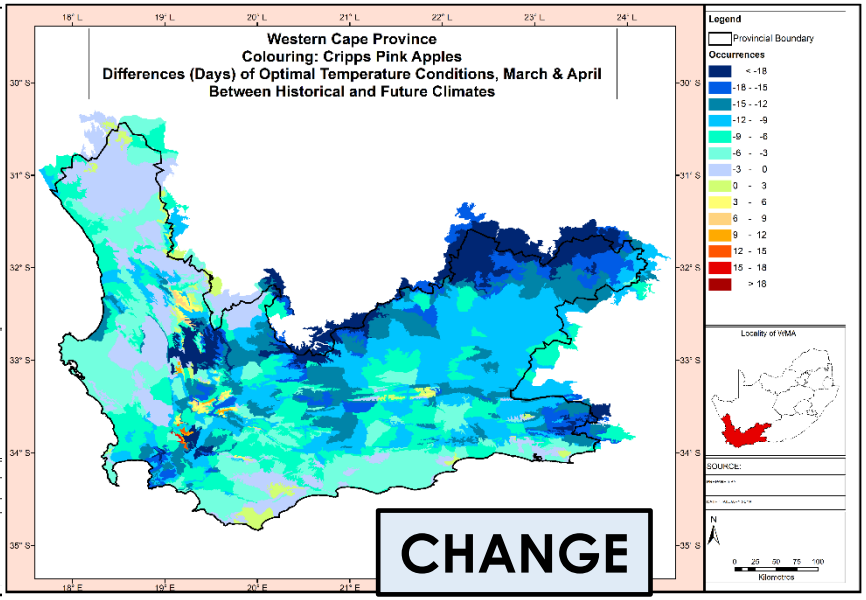
Historical period:
High values (> 30°C): inter-montane areas – stone fruit
Higher-lying and coastal fruit areas: < 28°C

Intermediate future:
Highest increases (> 2.5°C) in the interior, Langkloof
Higher-lying western interior (Bokkeveld): 2.3-2.6°C
Coastal: < 2.2°C

Change in days conducive to apple red colour development – March+April







Historical period:

Coastal: 18-30 days conducive

Langkloof: 24-30 days

Higher-lying interior: >21 days to >30 days

Intermediate future:

Coastal: 3-9 days

Langkloof: 6-12 days

Higher-lying interior: 9-15 days

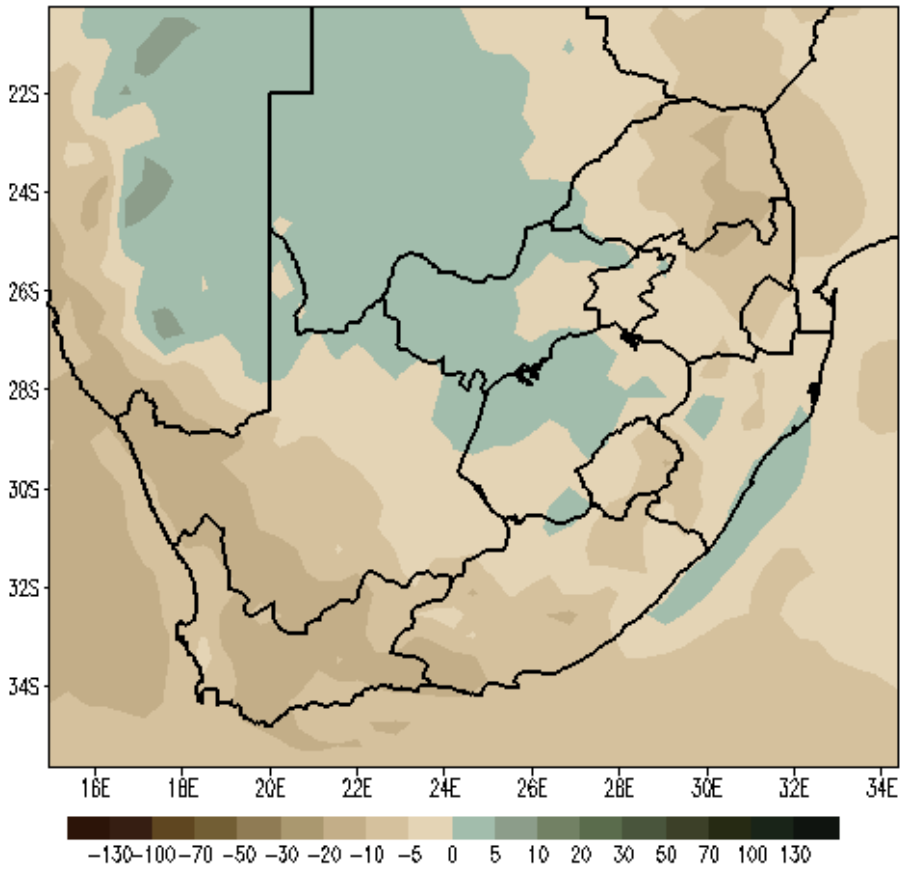
Change (reduction):

Coastal: -9 to more than -18 days

Langkloof: - 6 to more than -18 days

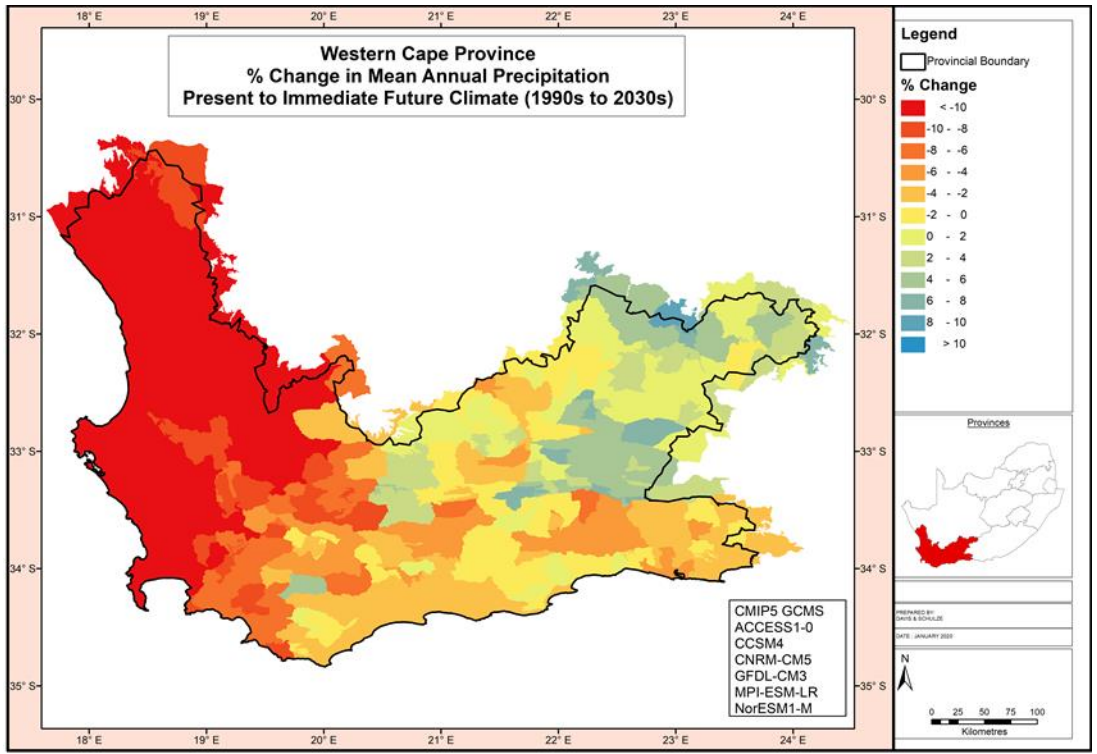
Higher-lying interior: -6 to more than -18 days

Change in future Mean Annual Rainfall



Multi-model ensemble projections

- Decrease > 40 mm p/a in the west; 10-20 mm in the south
- Increase by 10-20 mm in the north-east
- Not much deviation from zero in large parts of the central region



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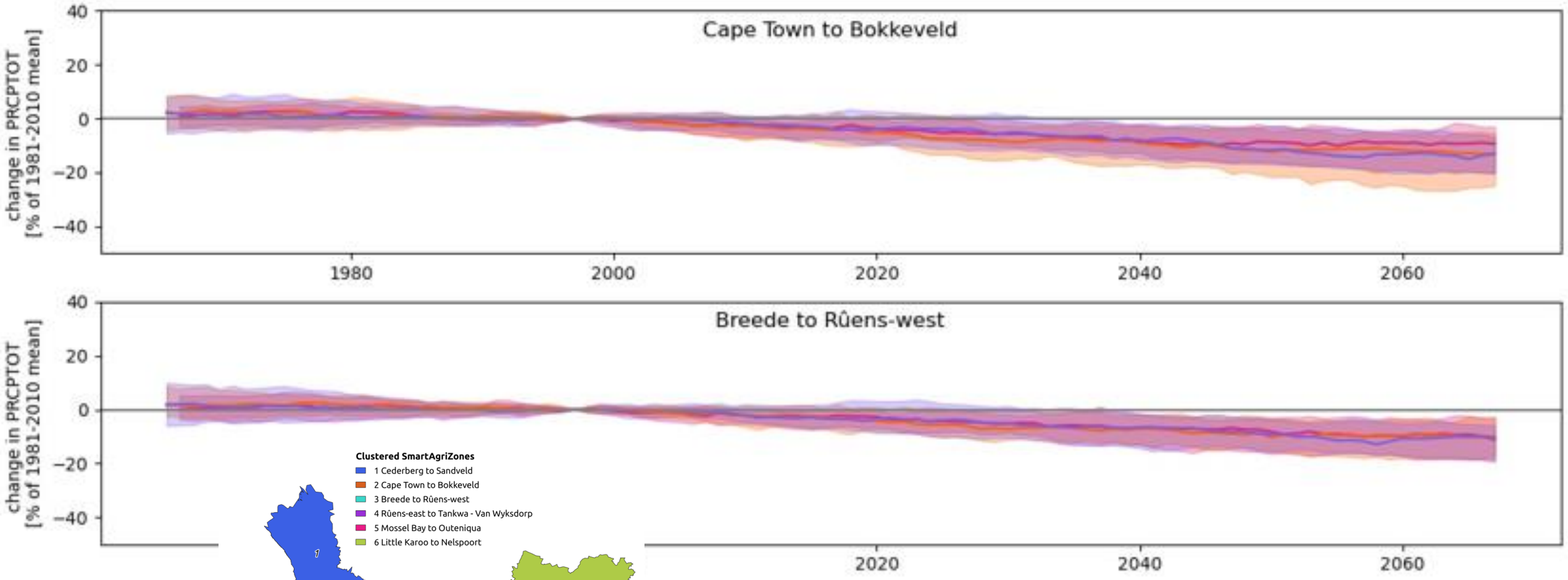
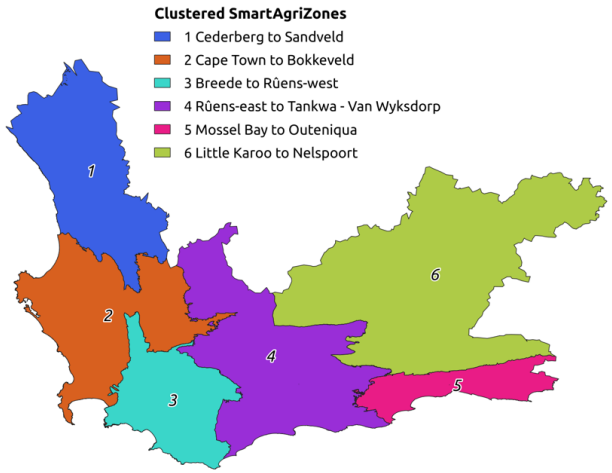
Change in mean annual rainfall (% of 1981-2010 mean)





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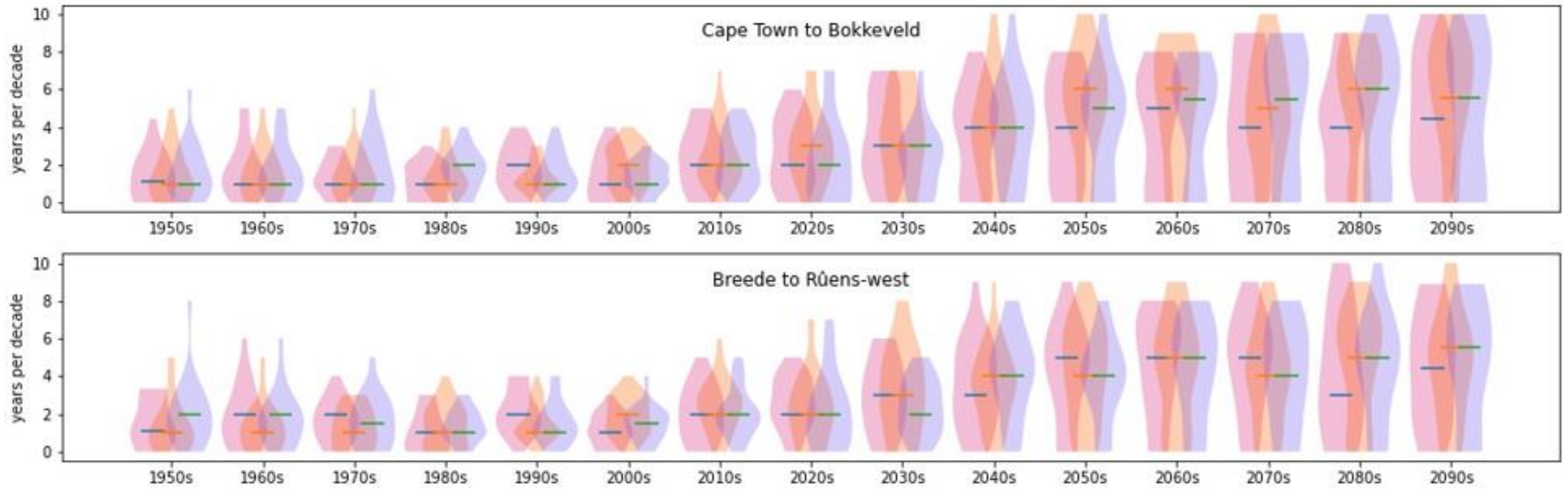
CSAG (2022)

Future rainfall and hydrology

- Future projections of rainfall are highly complex, and depend on the models, the scenarios, and the time periods used.
- Continued cycles of wetter and drier years for 20-30 years.
- More frequent dry years and consecutive dry years.
- More frequent high daily rainfall that can lead to local flooding.
- Possible increases in summer convective storms.
- Possible increases in precipitation in some regions are offset by increased evaporation due to higher temperatures.
- Changes in hydrology: runoff, stream flow, groundwater recharge.

Changes in years/decade with SPEI(12) < -1.0 (moderate drought)



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Other climate change risks relevant to fruit farmers

- Up to 20 additional **very hot days** annually (> 35°C)
- Increasing **sunburn** risk
  - Mid-summer: up to five more days per month in warmer production areas
  - South-western coastal regions show a lower increase in risk (up to two more days per month)
- Decreasing **frost** risk
- Increasing **heat unit** accumulation
- Additional life cycles in some **pests**
- Rising **evapotranspiration**; annual increases ~ 70-120 mm; more so in spring
- Possibly increasing **wind speed** in south-western regions
- Possibly increasing risk of **hail** linked to more convective / thunderstorm activity – especially summer rainfall areas

Summary of impacts on deciduous fruit farming

- The impacts of warming (+ ~2°C by mid-century) and associated climatic changes are area-specific.
- In all production regions, rising evapotranspiration will increase the irrigation demand, and water resources availability and efficient irrigation strategies will become critical.

Pome fruit production:

- The south-western coastal production regions (Elgin-Grabouw-Vyeboom-Villiersdorp, Greyton) are at greatest risk owing to losses in winter chill, but these areas become more suited to stone fruit.
- The north-western high-lying regions (Koue and Warm Bokkeveld) and the Langkloof remain suited to pome fruit production from a winter chill perspective, but growers will have to adapt to high temperature risks (e.g. sunburn protection).
- In all regions, the loss of days in autumn that are conducive to red colour development of apples will require a greater use of high-colouring cultivars and mutants.

Summary of impacts on deciduous fruit farming

Stone fruit production:

- The warmer parts of the Klein Karoo could become more marginal.
- Cultivars with higher winter chill requirements will need to be phased out.
- The northern parts of the Berg River region are projected to become much warmer and possibly drier than at present.
- Climatically suitable stone fruit cultivar choices will become an important component of adaptation responses.

Global and local transitions – a new era (Anthropocene)

1. **Land, soil, nutrient, water, and genetic transitions**: agro-ecology, regenerative agriculture, biodiversity, water productivity, ecosystem services, land use change, diversification
2. **Infrastructure transition**: road and rail, ports, water infrastructure, cold chain
3. **Energy transition:** renewable sources, distribution, efficiencies
4. **Dietary transition:** plant-rich diets
5. **Circular economy:** reduction and re-use of waste
6. **Population transition:** migrations partially driven by climate

> "Climate change impacts and risks are becoming increasingly complex and more difficult to manage. Multiple climate hazards will occur simultaneously, and multiple climatic and non-climatic risks will interact, resulting in compounding overall risk and risks cascading across sectors and regions." IPCC 2021

Action and hope are needed

- The **good news**:
  - we understand the causes of the problem and pathways out of it
  - **we already have most of the solutions**
  - **it's not too late to do something about it and prevent the worst impacts**
- Many climate solutions can provide concrete **co-benefits** for human well-being, sustainable development, prosperity, security, and environmental health
- We need to **act now** and do so **collectively with a shared vision of a better future**
- **Every year matters, every choice matters, every action matters.**

Thank you

Stephanie.Midgley@westerncape.gov.za

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