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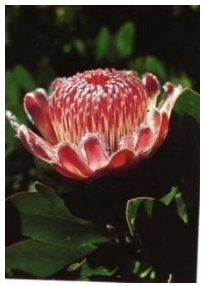





Climate Change Models and Scenarios:

Approaches for assessing integrated impacts on agriculture and biodiversity

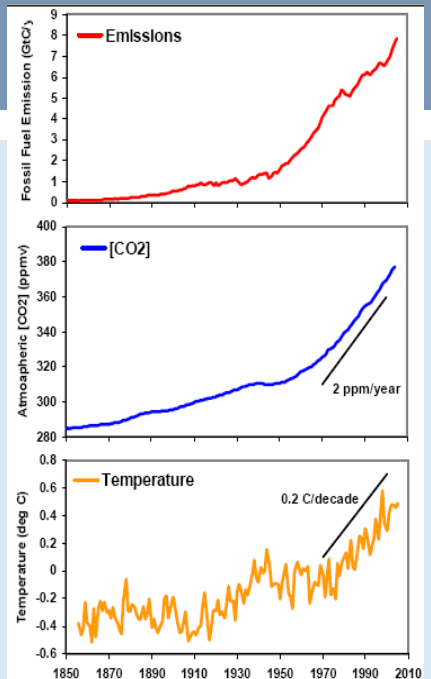
Courtesy Dennis Laidler, DEADP

Stephanie Midgley

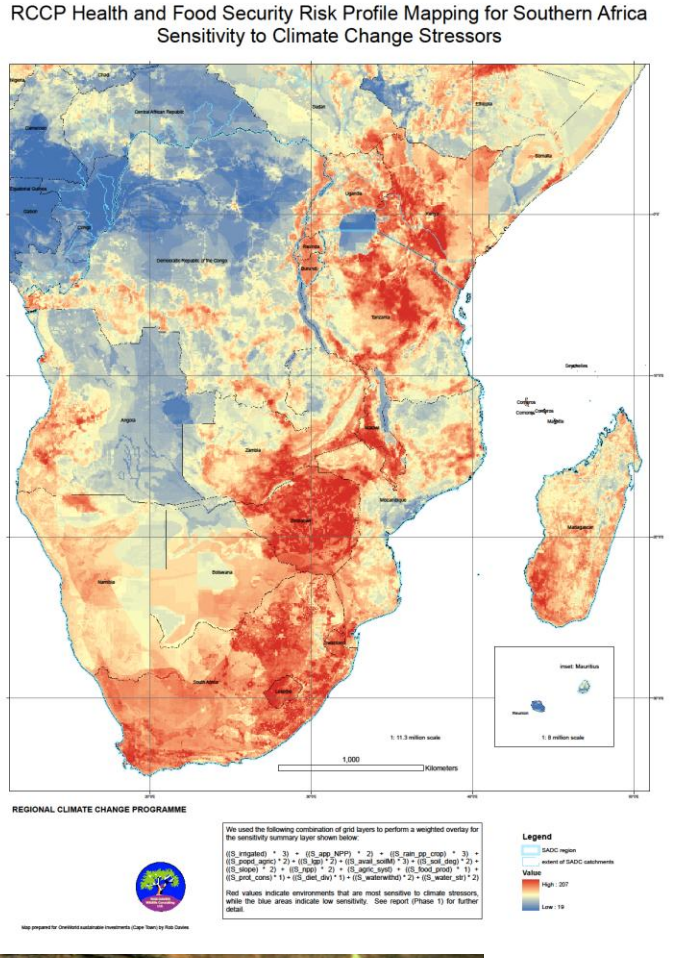
23 June 2011

CAPE Partners' Conference

Elsenburg



Agriculture and biodiversity are linked in multiple ways, climate change adds further dimensions



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Impact assessment for agric and biodiversity

CC Impact = Sensitivity + Exposure to climate

Data provide evidence for historical and current exposure

How do we project future CC-driven exposure?

1. General Circulation Models (coarse scale, global)
2. Downscaled GCMs (finer scale, regional)
3. Plausible futures (scenarios)

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Modelling inputs: sources of uncertainty

1. Which GCMs, RCMs, downscaling techniques?
2. Which greenhouse gas emissions pathway (SRES)?

Scenarios of global socio-economic development pathways and related energy use

3. How far into the future (time scales)?

Near-term 2020-2030, medium-term 2046-2065, long-term 2080-2100

4. Which spatial scale?

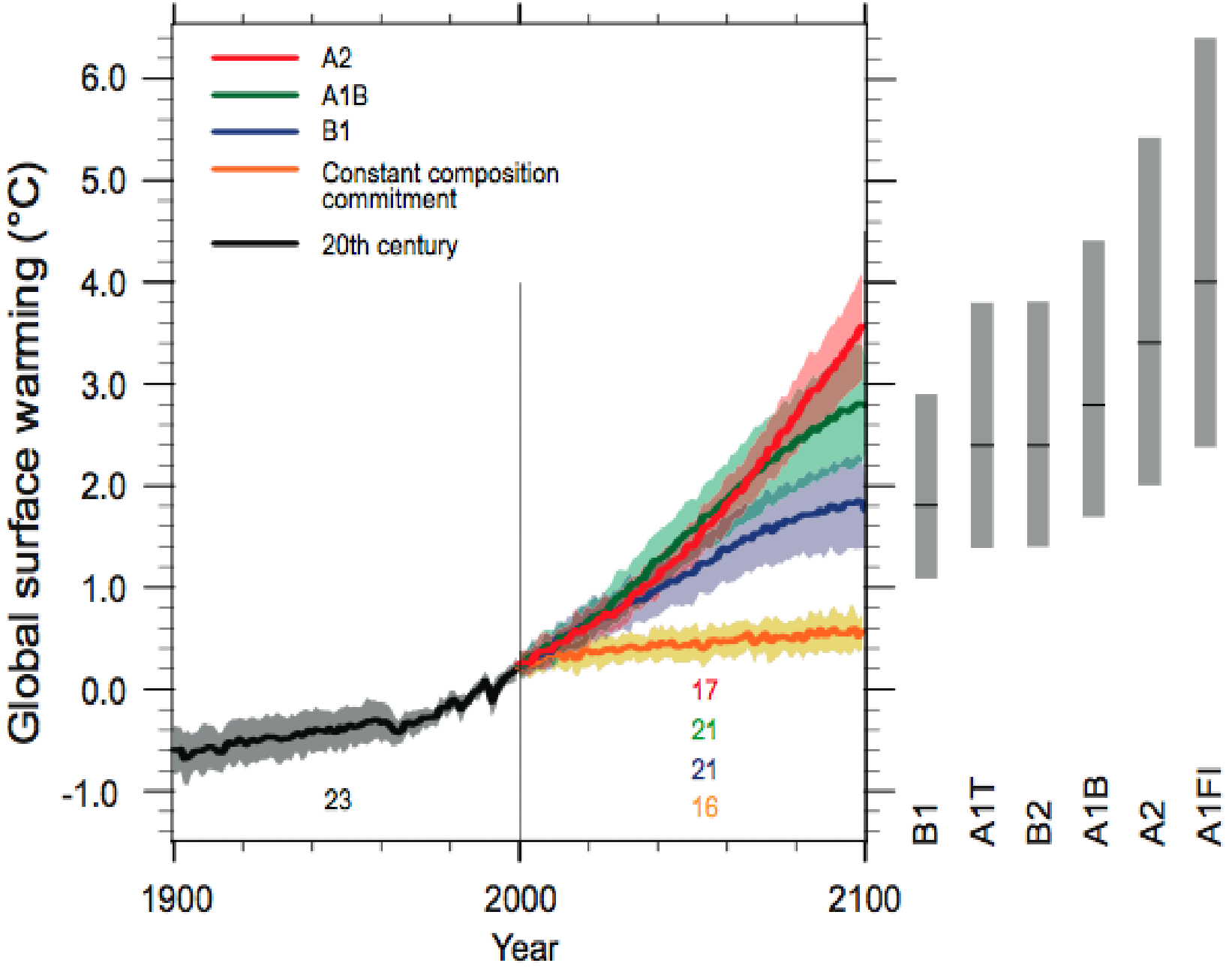
Global, continental, country, province, biome, catchment

5. Which temporal scale and statistical approach?

Daily mean or min/max, monthly mean or min/max, seasonal mean/total, extreme events

6. Which variables?

Temperature, rainfall, wind


A2
A1B
B1
Constant composition commitment
20th century
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
1900
2000
2100
Year
23
17
21
21
16
B1
A1T
B2
A1B
A2
A1FI

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CC projections for South Africa

From: Second National Communication (draft), input by CSAG, UCT

- 10 GCMs (temperature, rainfall) and 10 statistically downscaled GCMs (rainfall)
- SRES A2 emissions scenario (moderate to high growth in GHG concentrations)
- 2046-2065 above baseline (1961-2000)

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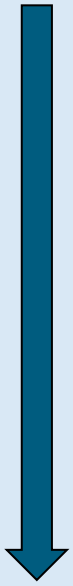
Components of CC projections

- Likely direction of change (reduced, increased, no change)
- Attributes of indicated change (mean, extreme, derived)
- Absolute magnitude (or probable range of magnitude) of change



Decreasing robustness

[increasing associated level of uncertainty – envelope of possibilities]

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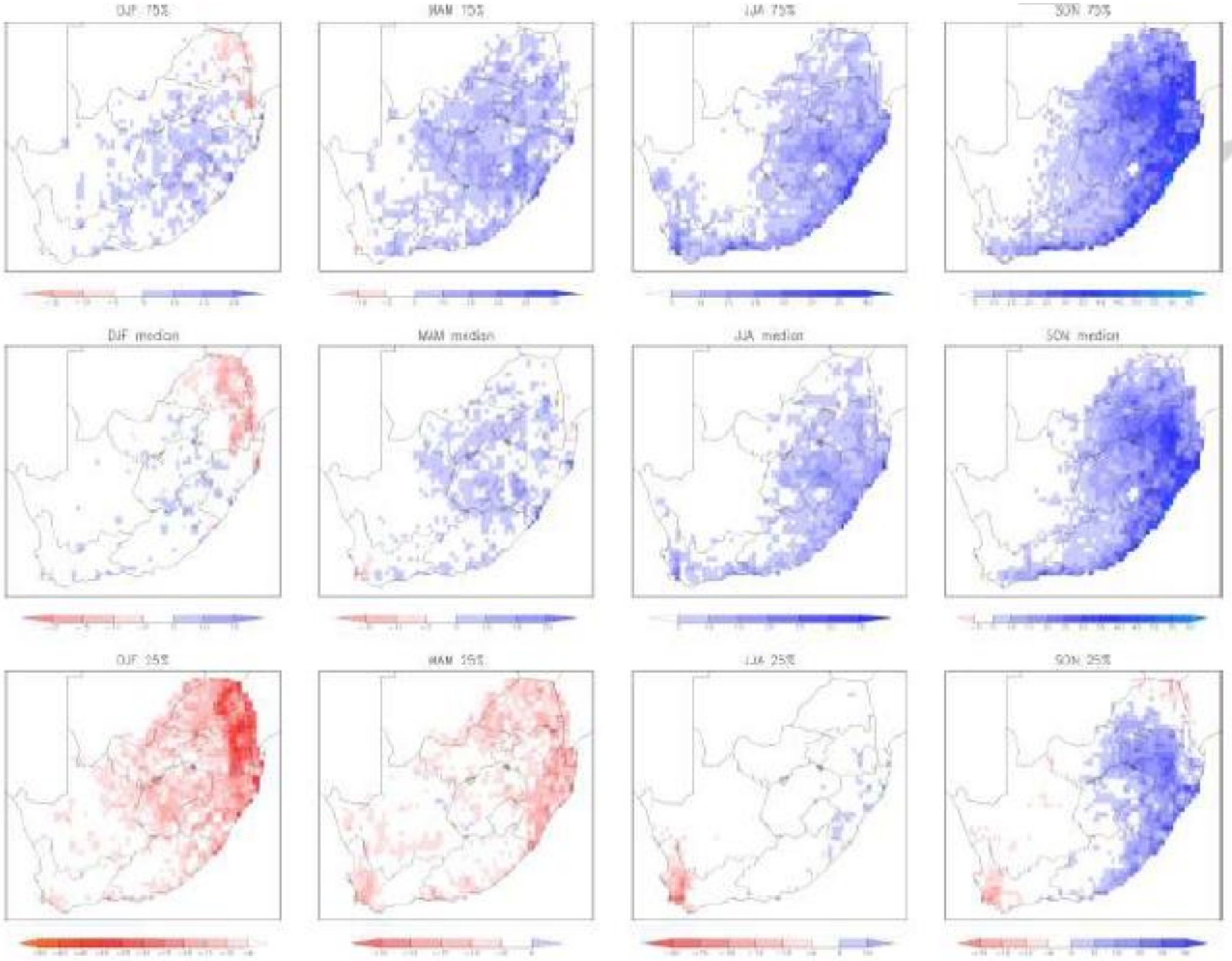
Projections: climate system and temperature

- Shifts in the spatial west-east positioning of the summer rainfall gradient
- Inhibition of weaker convective storms
- Increase in heavy rainfall events
- Increase in orographic rainfall (over mountain ranges)
- Weaker penetration of frontal systems (drier western Cape)
- Warming, more so in the interior (2-3°C) than the coast (1-2°C) by 2050

Problems for the Cape:

Cannot yet position (spatially) the transition between future summer and winter rainfall regions

Influence of mountain ranges still poorly understood – impacts on streamflow


DJF 75%
MAM 75%
JJA 75%
SON 75%
DJF median
MAM median
JJA median
SON median
DJF 25%
MAM 25%
JJA 25%
SON 25%

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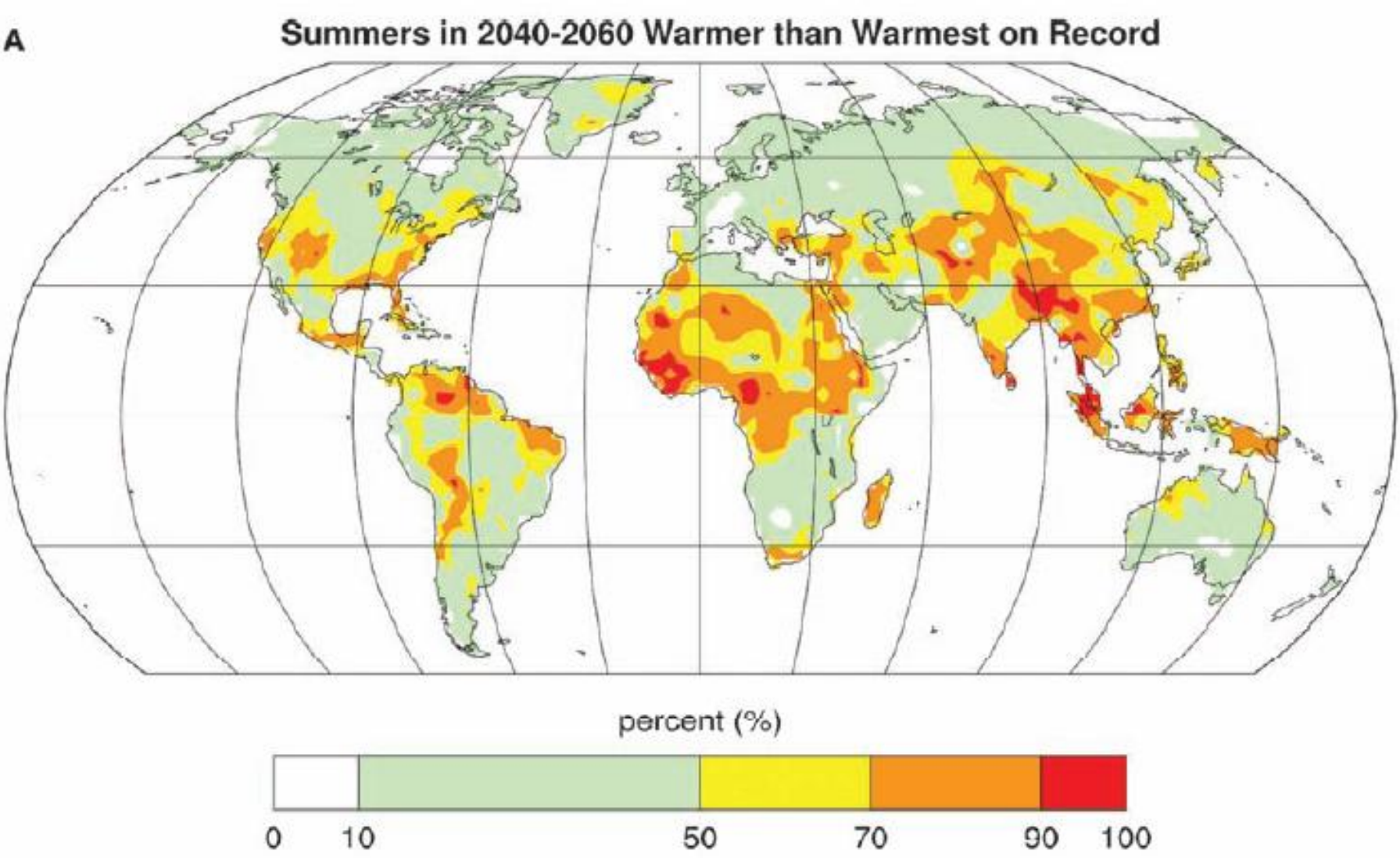
Drivers of impact which are poorly modelled

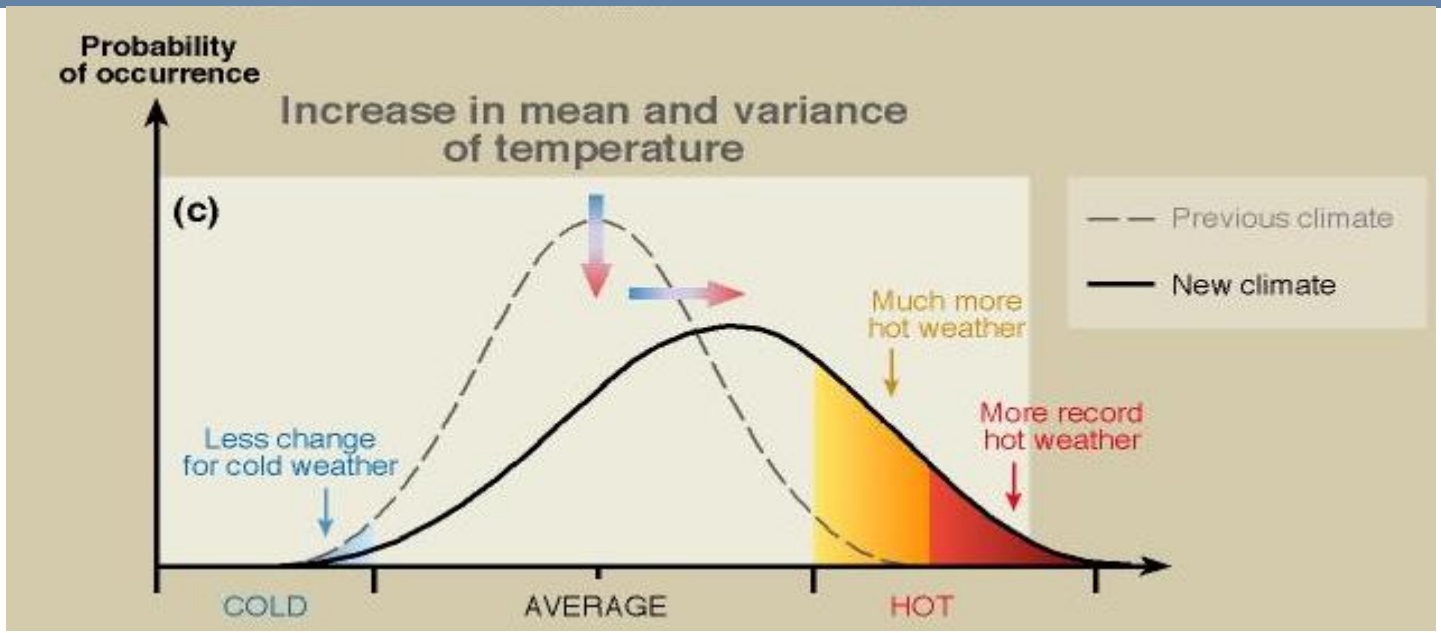
- Interactions with ENSO and other ocean anomalies
- Changes in the start, end and duration of the rainfall season
- Number of dry days and rainfall days
- Timing, frequency, intensity and duration of dry spells
- Timing, frequency, intensity and duration of heavy rainfall events
- Timing, frequency, intensity and duration of hot spells
- Rising atmospheric CO_2 concentration
- Changes in wind speed, direction, and relative humidity
- Local influences on micro-climate (topography, slope, water bodies, veg)

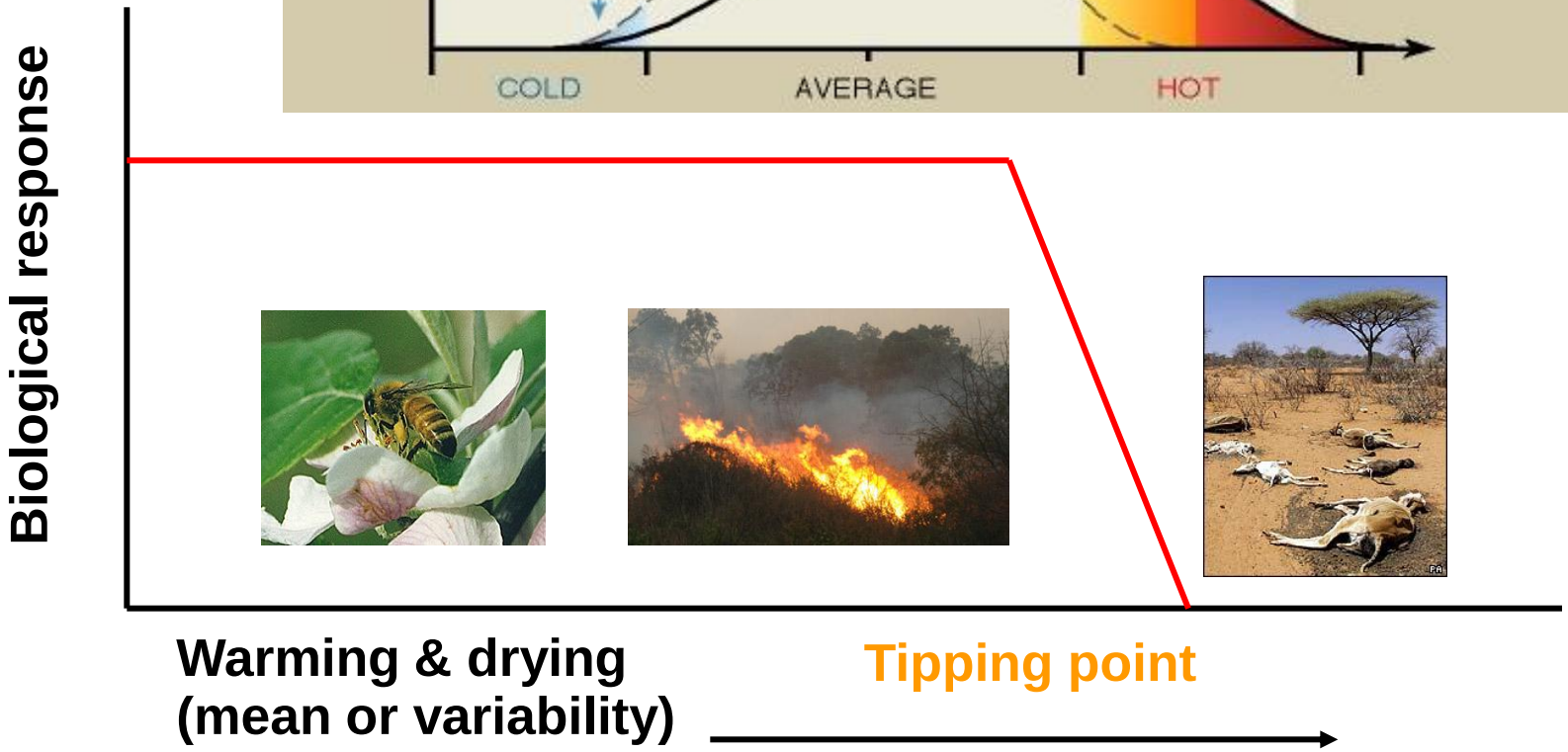
Early attempts at modelling are coarse and suffer from high uncertainties.



Battisti and Naylor (2009) *Science*

Impacts driven by threshold exceedance





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Alternative approaches for policy and planning

- High resolution (downscaled) modelling will continue to improve, in the meantime we need approaches that account for uncertainties
- Make use of plausible futures based on a range of possible outcomes e.g. various climate possibilities combined with various development / economic / conservation possibilities
- "Stress test": Capture 80% of uncertainty (between 10th and 90th percentiles)
- Such approaches can also assist in assessing the cross-sectoral integrated impacts of CC which models cannot capture
- Output: scenarios on which to base sensible policy and adaptation choices that maximise resilience and are "no regrets"

Example: CC impacts on agricultural profit

Climate scenario	Field crops	Horticultural crops	Animal husbandry	Aggregated
10th	-66.2%	-32.3%	-31.9%	-44%
50th	-36.7%	-9.8%	-20.8%	-24%
90th	-12.9%	3.7%	-11.9%	-8%

Impact of climate change on net profit as a % change by 2050 in three agriculture sub-sectors. The 10th, 50th and 90th percentile changes combine best, median and worst-case projected impacts of temperature and rainfall, projected at the provincial level and aggregated to national level. Non-linear effects (thresholds) ignored!

Source: GF Midgley, RJ Scholes, G von Maltitz, E Archer, J Blignaut, 2011

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Conclusions and recommendations

- Climate scenarios will have significant uncertainty for some time to come, so impacts community should *assess full range of plausible future climate change*.
- Such modelling efforts will improve our understanding, and *provide policy guidance for robust adaptive action*. Long-term adaptation responses must be *flexible* to account for great uncertainty.
- Decisions and planning must rest on *integrated* and multi-pronged approaches, based on *risk reduction and risk management* principles.


Thank you for your attention
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