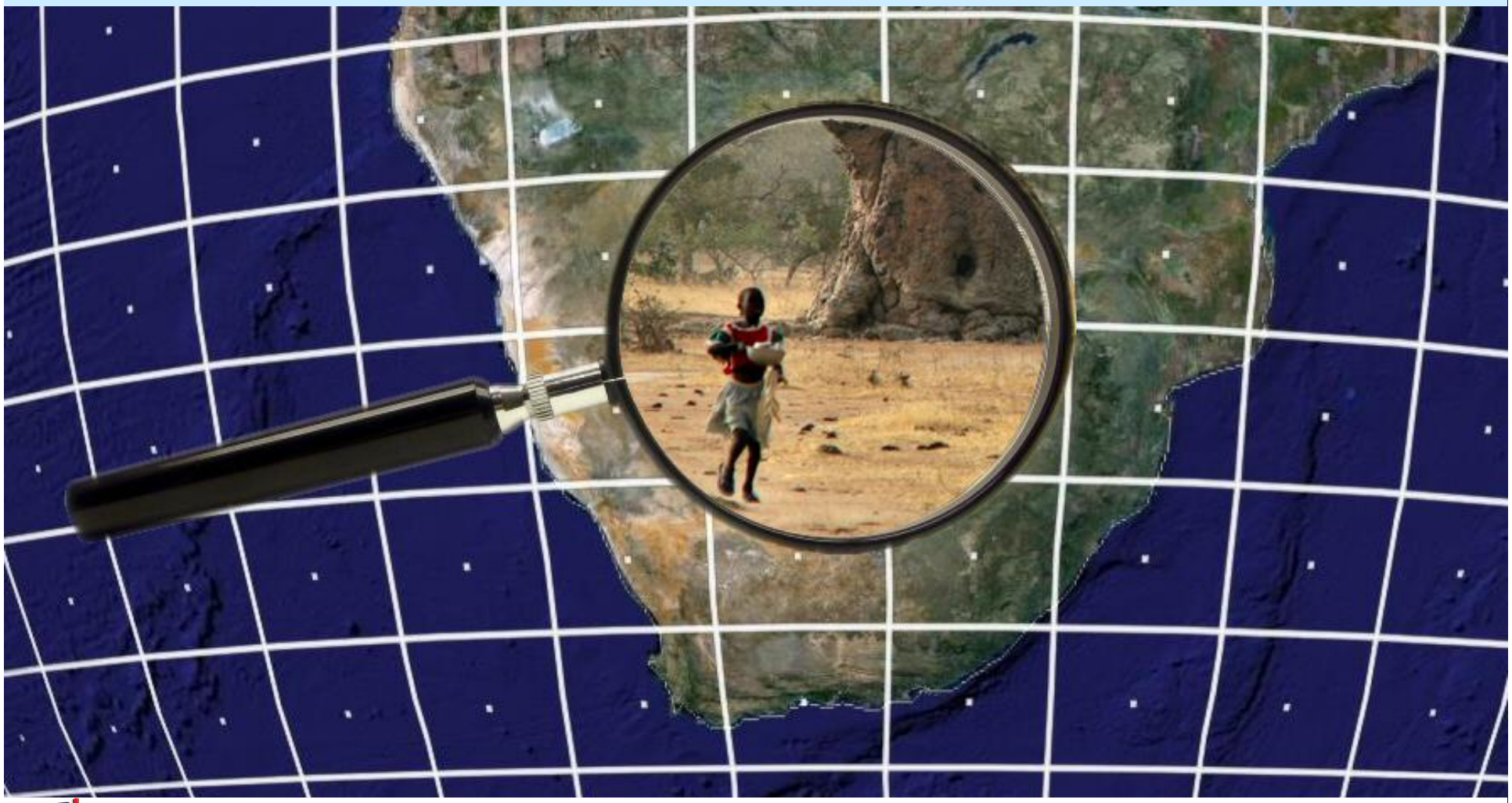
Climate change: threats, challenges, and opportunities



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Bruce Hewitson
University of Cape Town

Climate science: framing thoughts

Some thoughts to frame your thinking around:

a) I am not here to convince you!

b) Climate change is nuanced with simple messages, and complex detail

c) Uncertainty is intrinsic in a quasi deterministic coupled system

d) Context is paramount, especially as regards scales and sectoral interests

e) Warming of the last century is “unequivocal”

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Sampling the “threat-space”

Research:

- Diversion of research foci / application driven research agenda
- Politicization of science *(e.g. USA Virginia state attorney general)*

Society:

- Exceeding societal design thresholds *(e.g storm water systems)*
- Increased frequency of event-based disasters *(e.g. Moscow, Pakistan)*
- Changes in resource availability *(e.g. shrinking glaciers for Asia water)*
- Polarization / conflict *(e.g. resource availability, trade conflicts)*
- Tensions in the plurality of value systems *(e.g China vs USA vs SA)*

Economic:

- Business as usual becoming unsustainable *(e.g. agricultural systems)*
- Shifting and fluid economics *(e.g. realignment in investments)*
- New centers of power *(e.g. China, Brazil)*

What's happening? (the evidence basis)

In general:

- Warming
- Wetter and drier
- More extreme events
- Ocean acidification
- Glacier melt
- Increased drought and flood
- etc …

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A metaphor for climate science

Learning to read

The cahllaenge of birdgnig the sceicne-soictey dvidie

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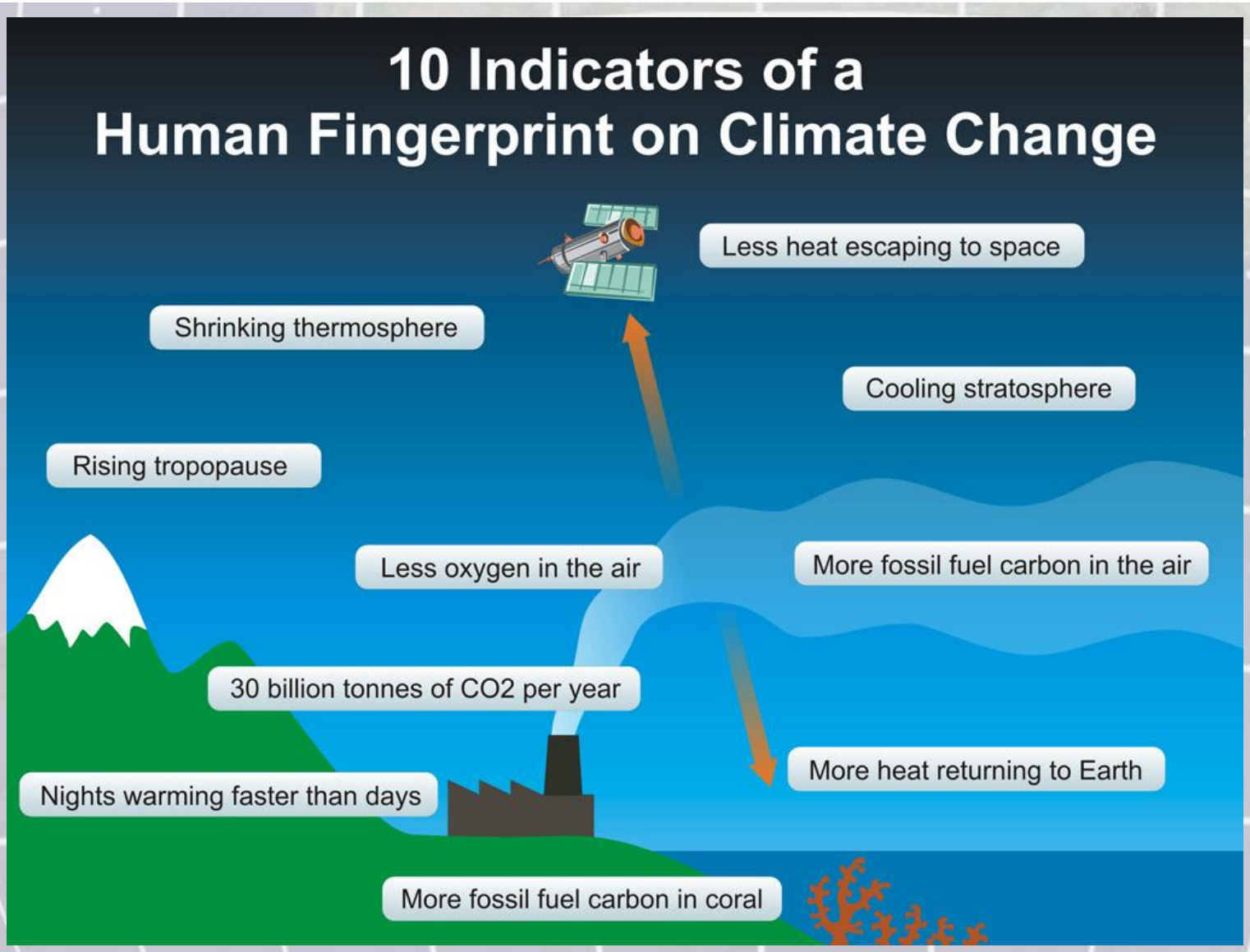
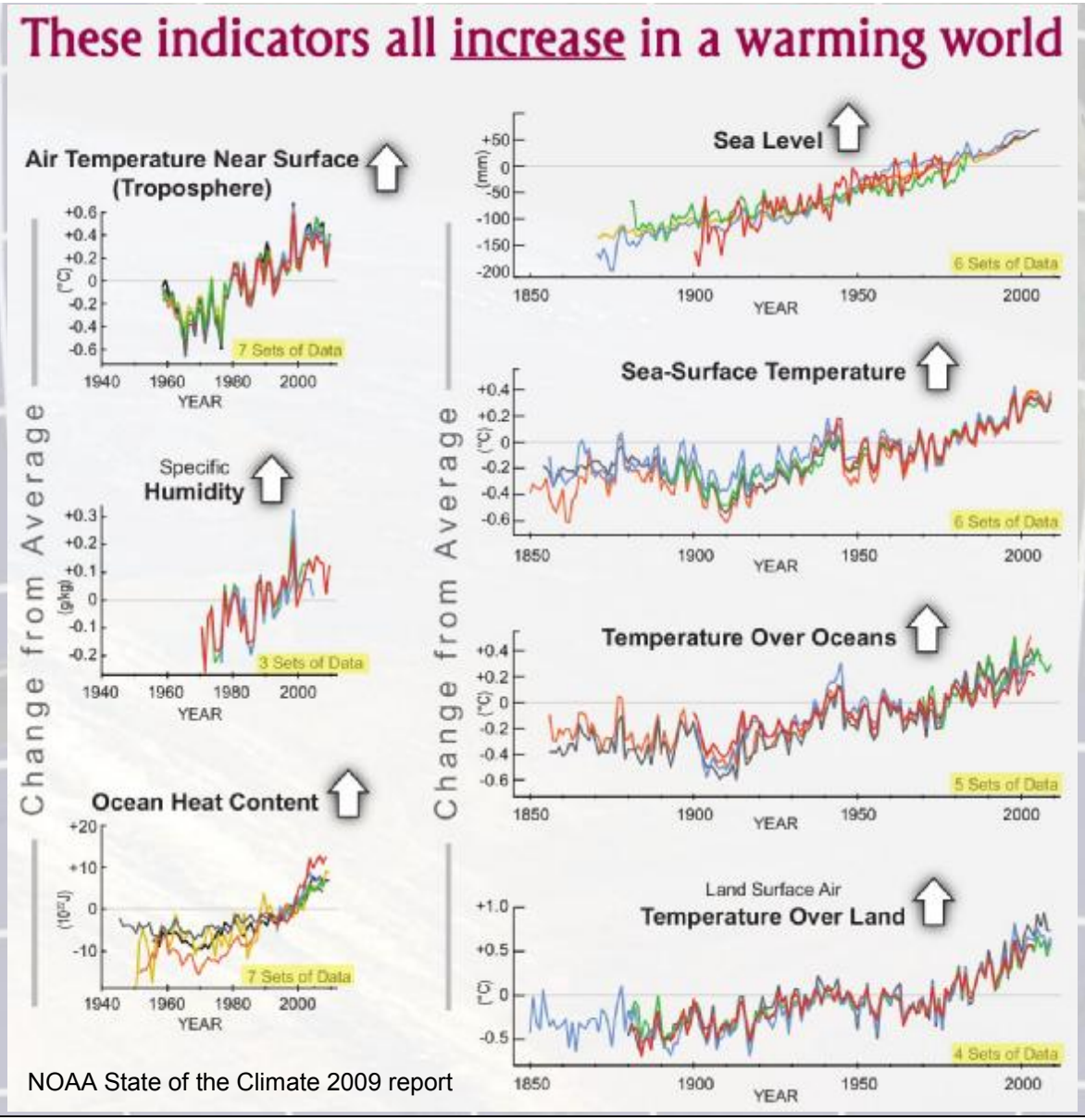
A unique context



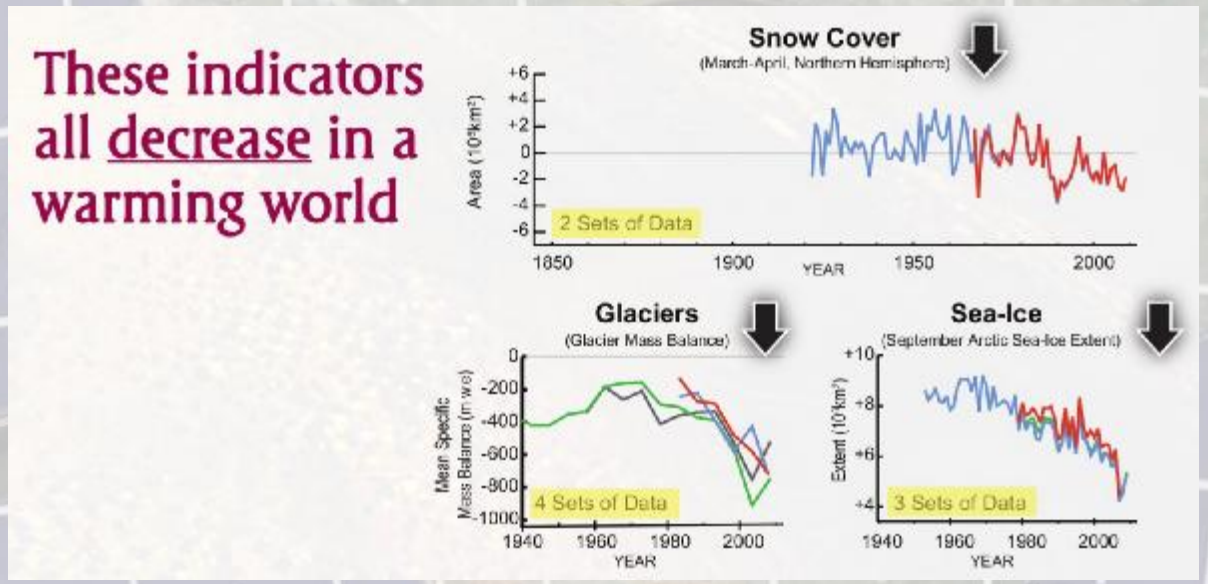
NOAA State of the Climate 2009 report

A unique context



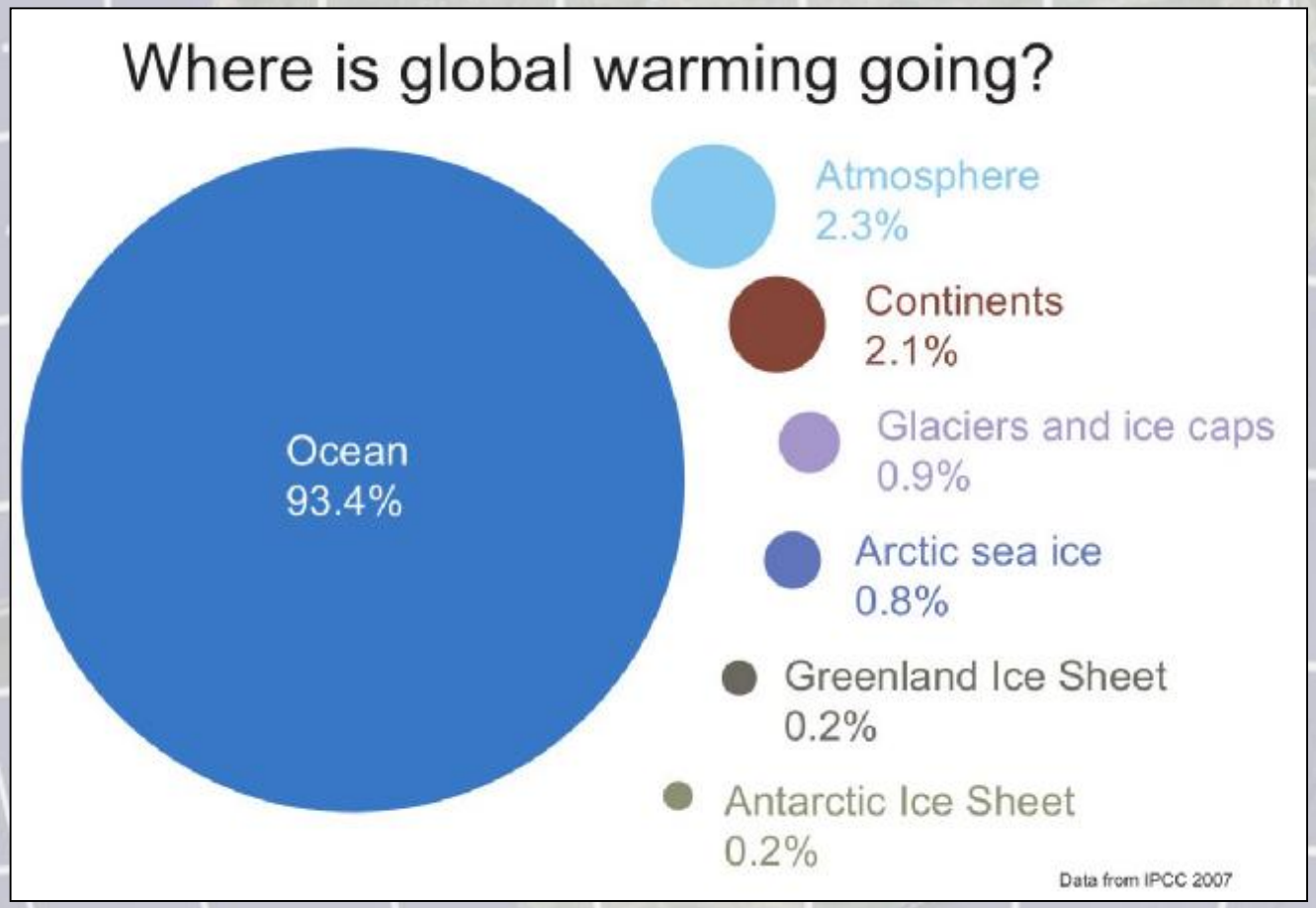
NOAA State of the Climate 2009 report

A unique context



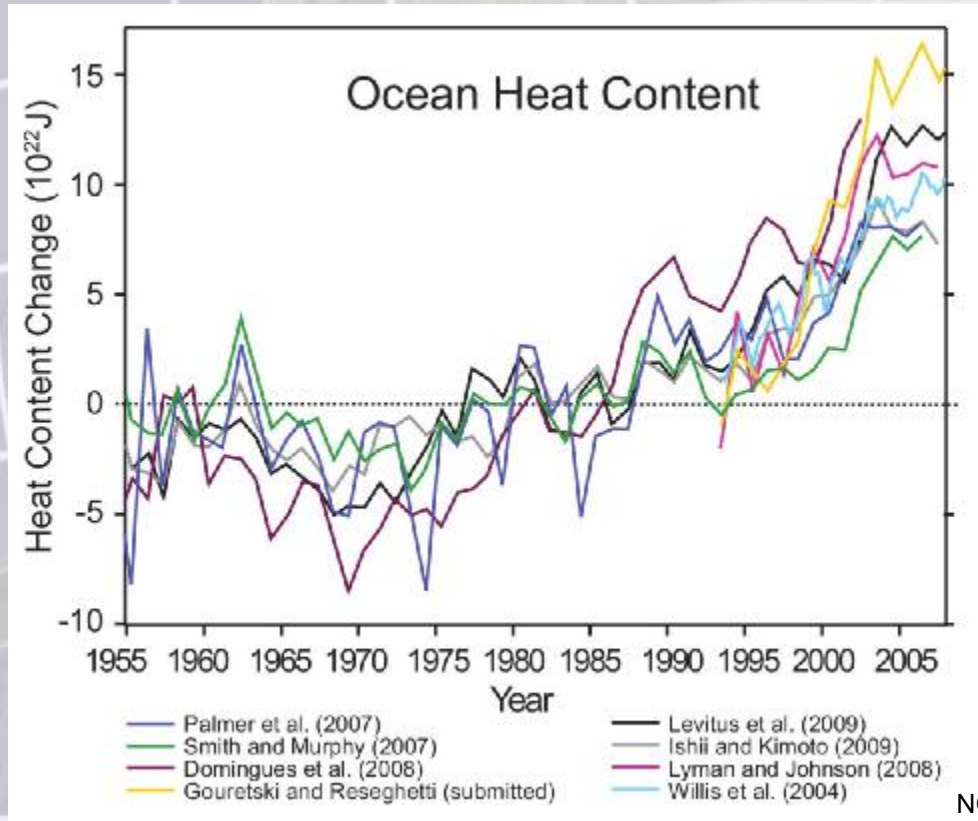
NOAA State of the Climate 2009 report

A unique context



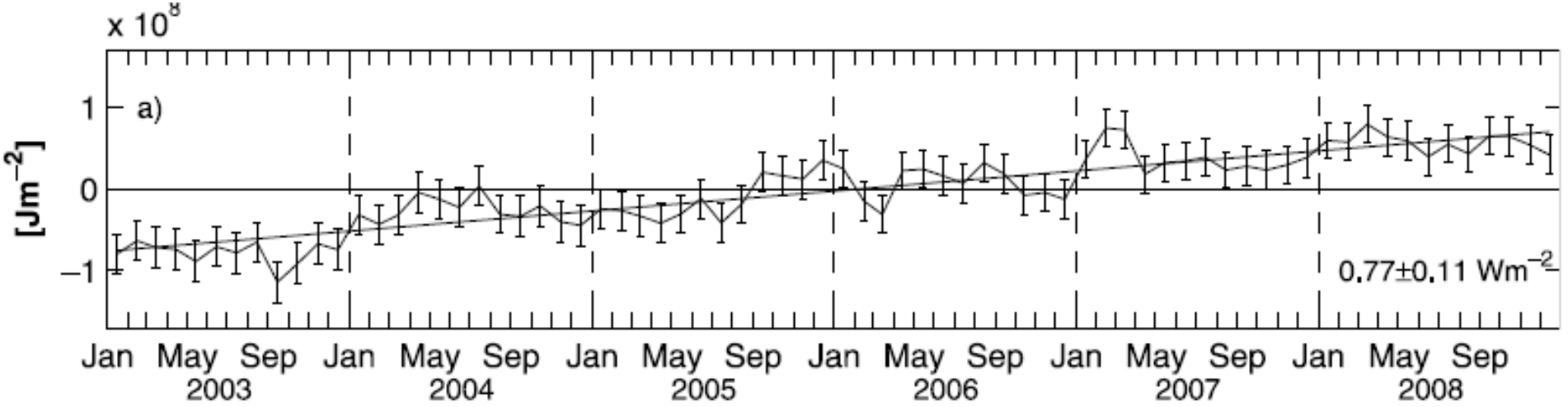
NOAA State of the Climate 2009 report

A unique context

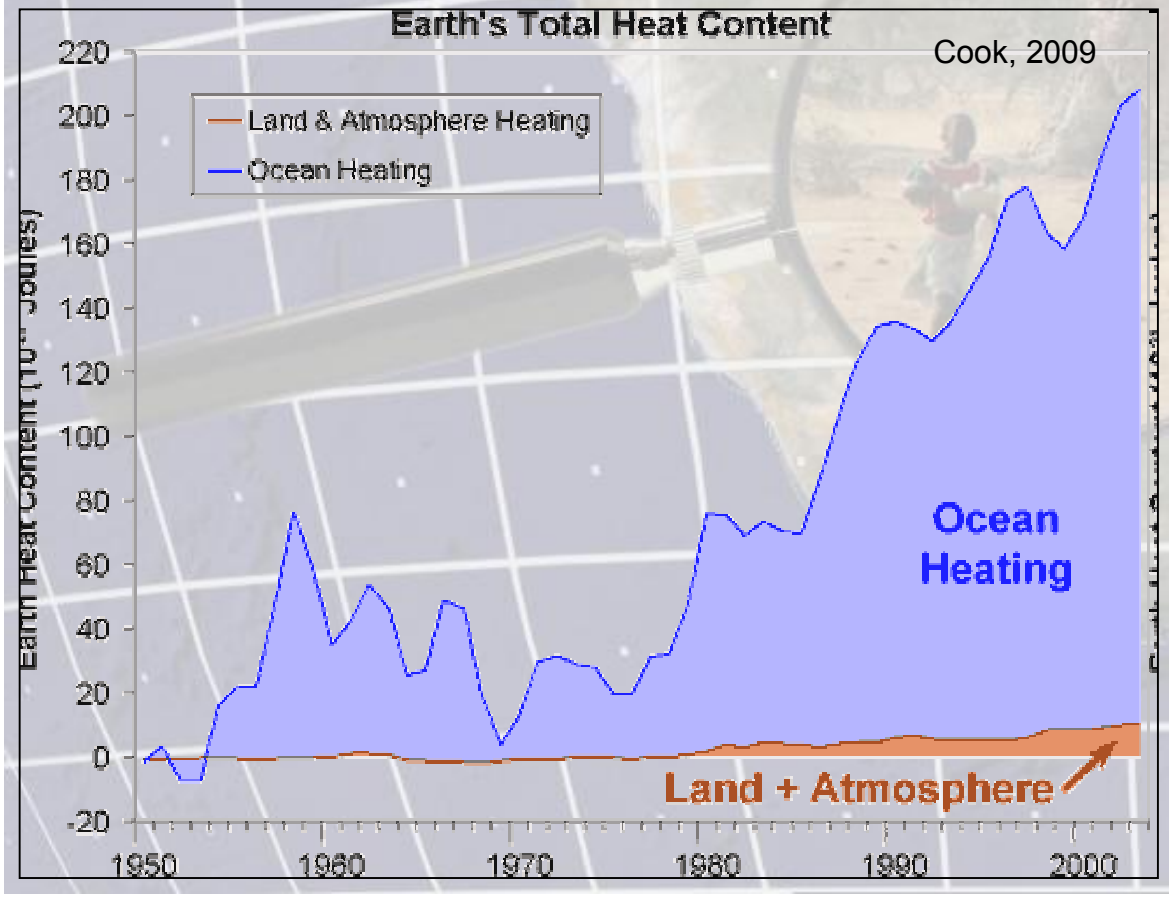


The graph shows changes in ocean heat content in joules (a measure of energy) compared to the 1955-2002 average. The different colored lines represent various independently produced analyses of ocean heat content data. The most recent studies, in which recently discovered data errors have been corrected, show the strongest warming.

NOAA State of the Climate 2009 report

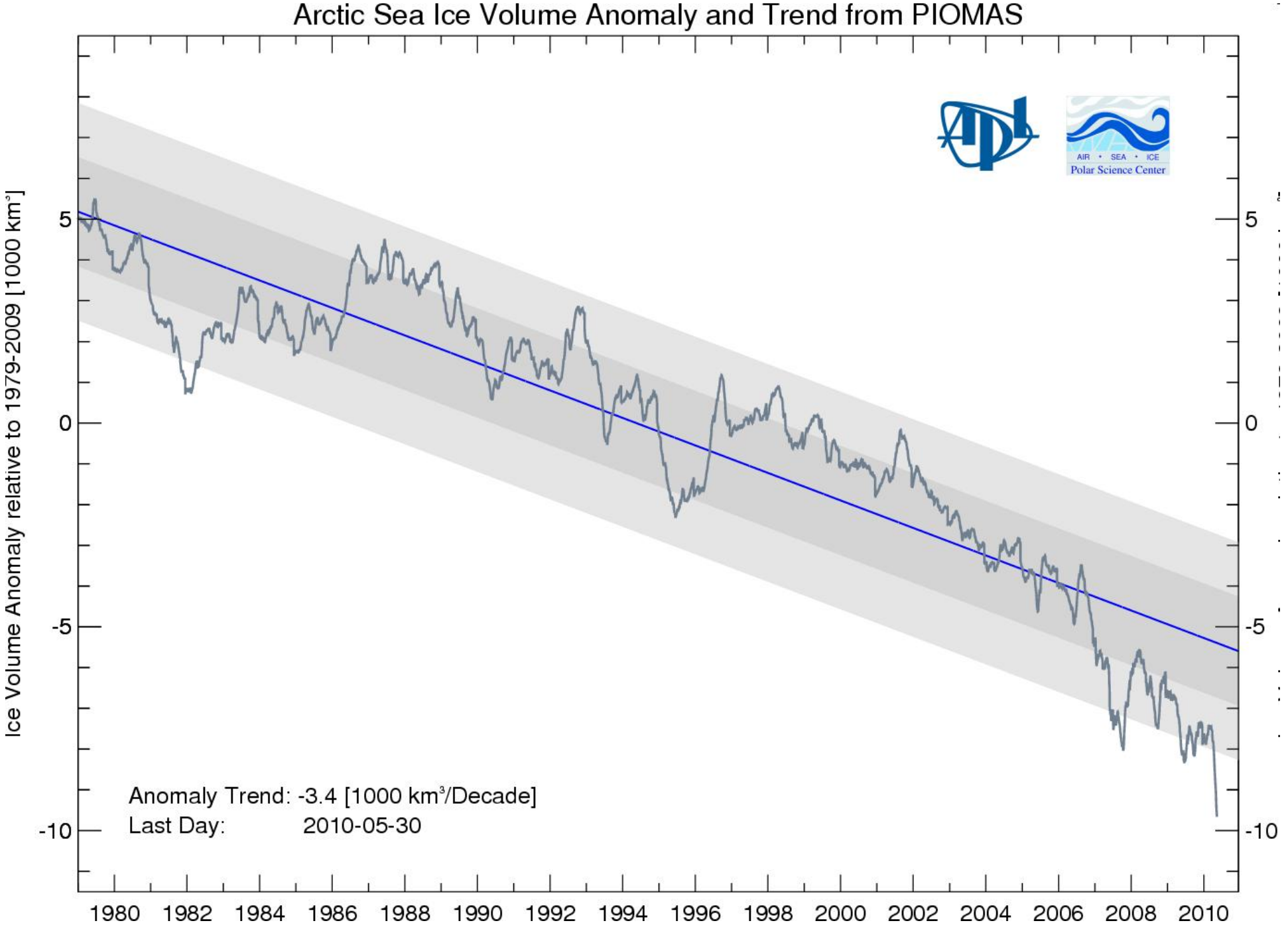


Heat content un upper 2000m of ocean
von Shuckmann, Gaillard, & Le Traon (2009)

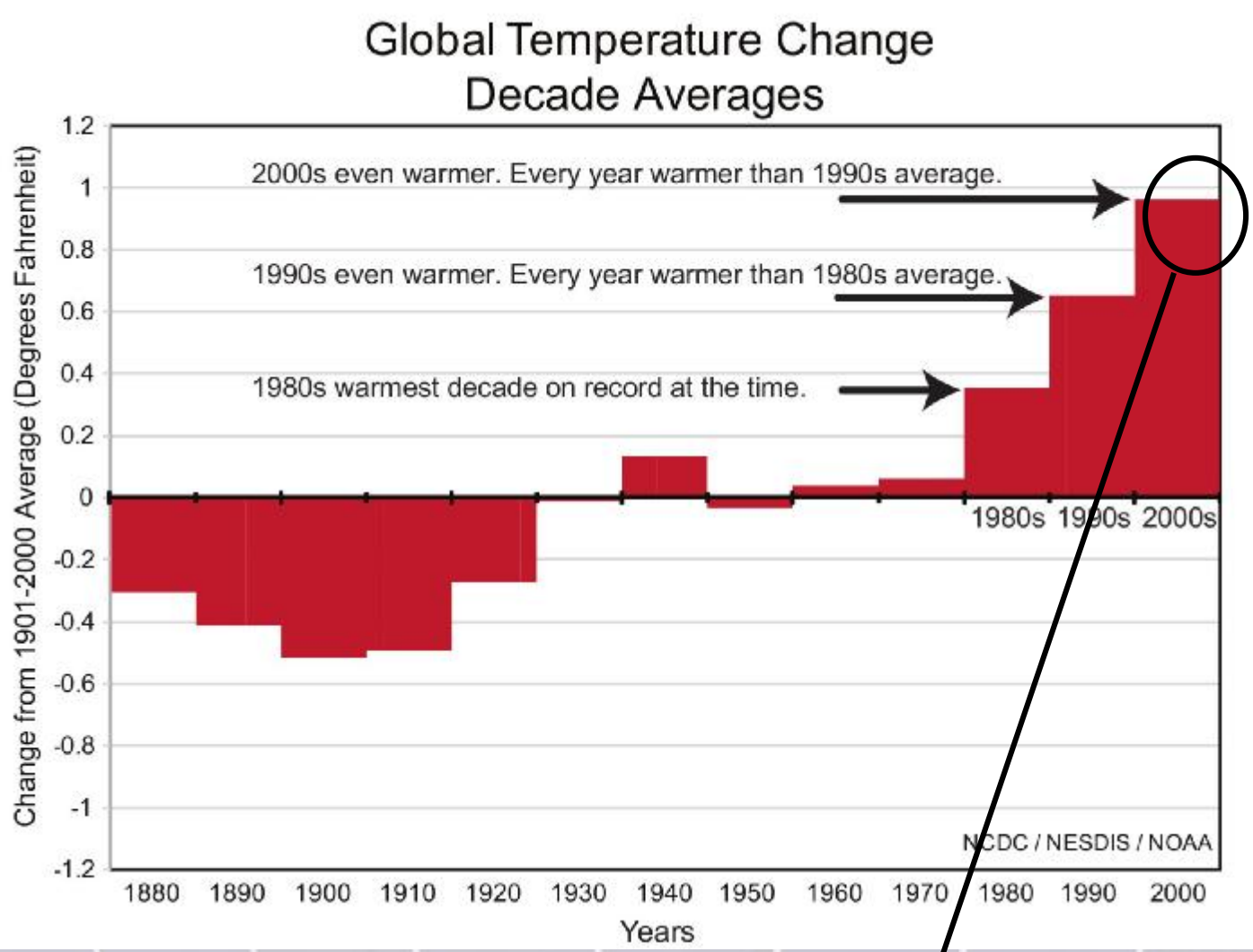


Global temperature is not the optimal metric

© B Hewitson


Arctic Sea Ice Volume Anomaly and Trend from PIOMAS
Ice Volume Anomaly relative to 1979-2009 [1000 km³]
5
0
-5
-10
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
AIR • SEA • ICE
Polar Science Center
Anomaly Trend: -3.4 [1000 km³/Decade]
Last Day: 2010-05-30

A unique context



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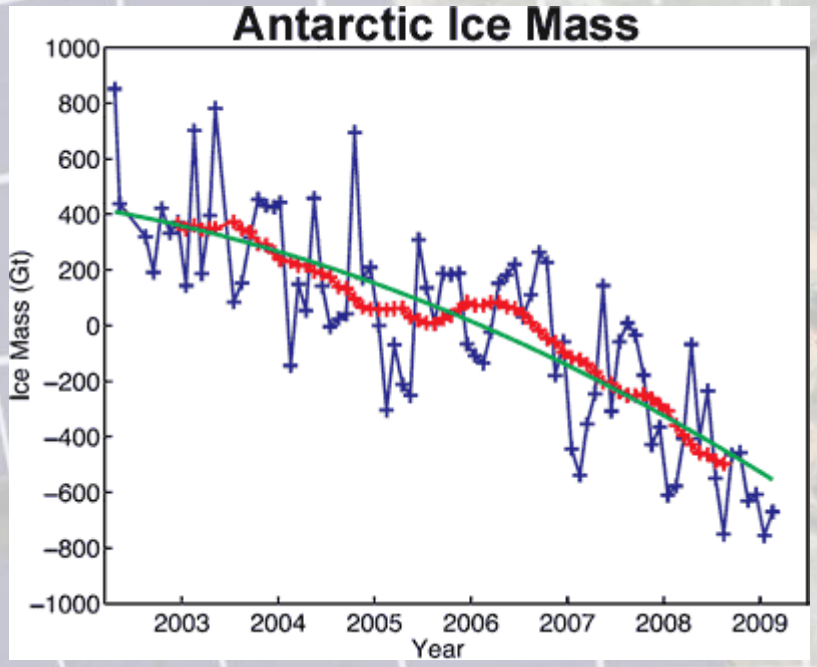
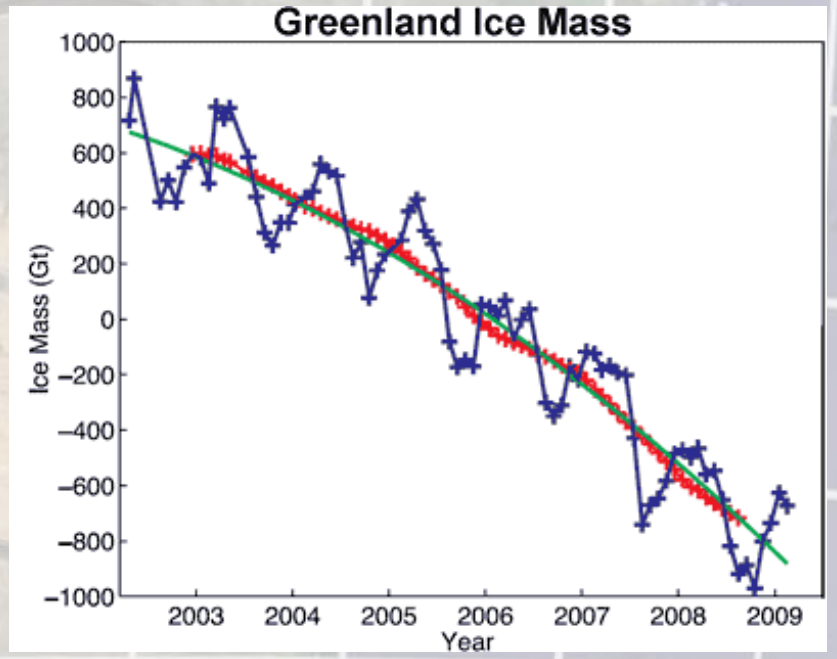
The sun's output at a current extended minimum

A unique context





Velicogna (2009)

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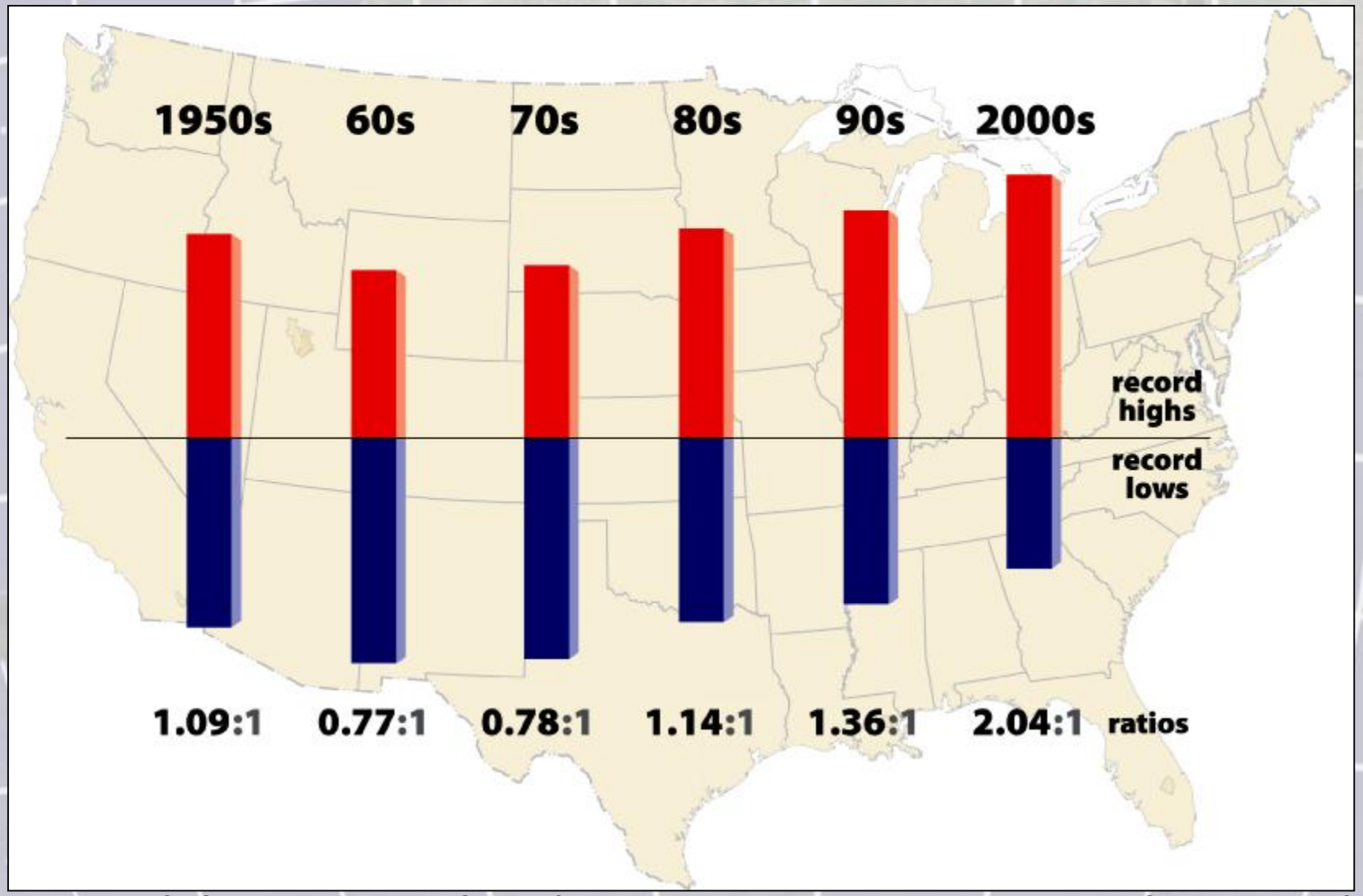
A unique context



©UCAR, graphic by Mike Shibao, from paper http://www.agu.org/journals/pip/gl/2009GL040736-pip.pdf

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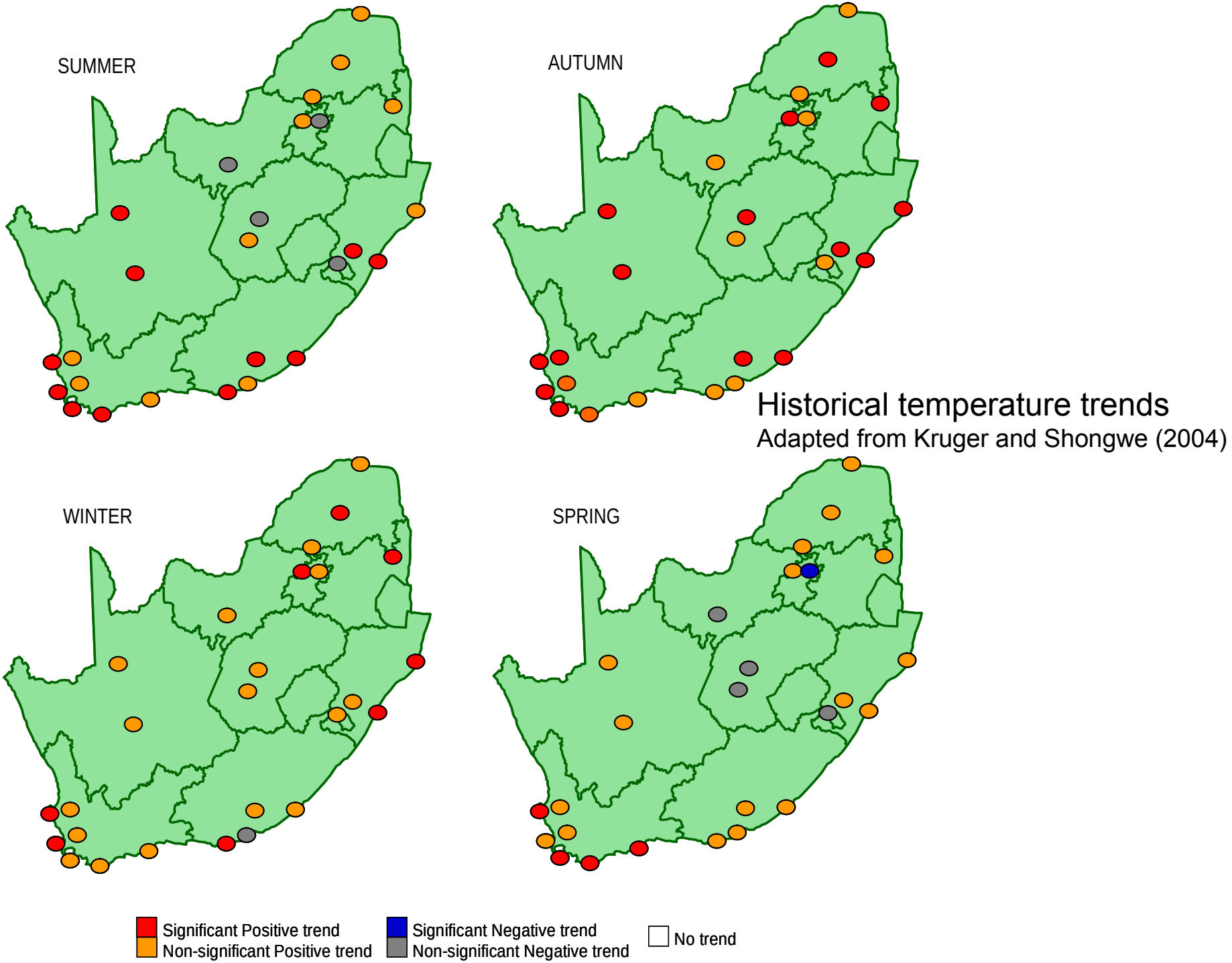
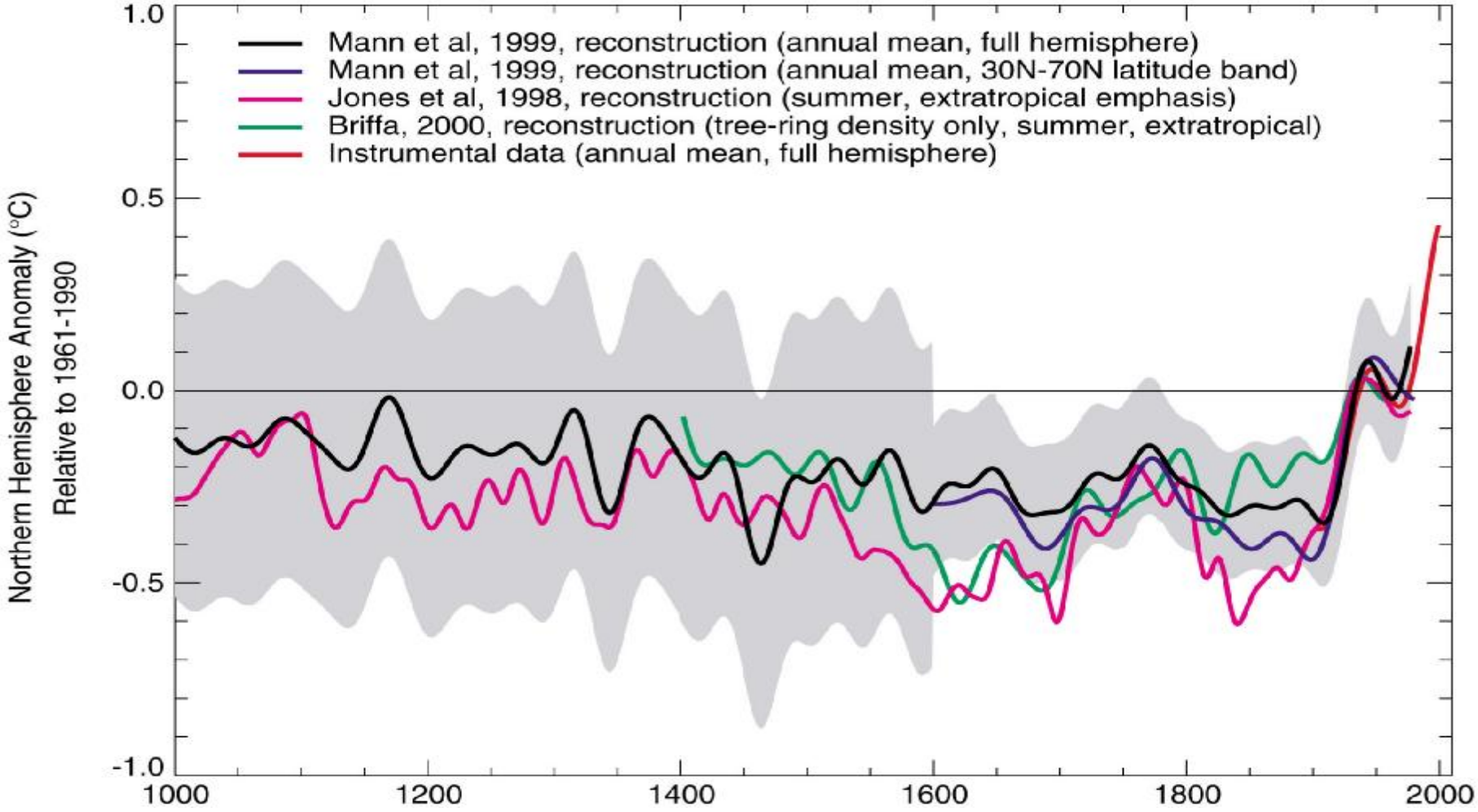
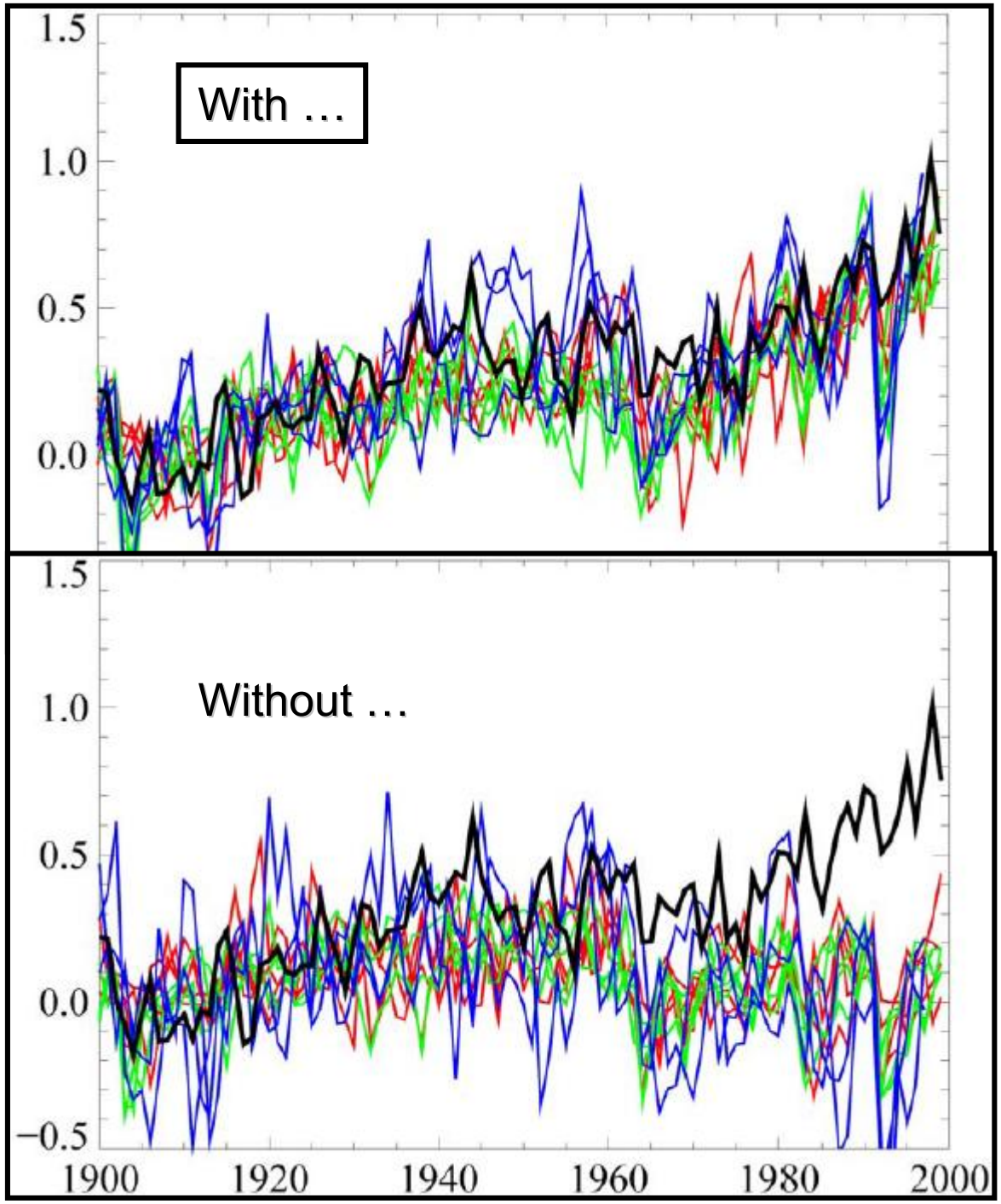

SUMMER
AUTUMN
WINTER
SPRING
Historical temperature trends
Adapted from Kruger and Shongwe (2004)
Significant Positive trend
Non-significant Positive trend
Significant Negative trend
Non-significant Negative trend
No trend

"Reconstructions for the last 1000 years indicate that this warming was unusual and unlikely to be entirely natural in origin" (IPCC)

There is no identified physical process, other than human induced change in greenhouse gas concentrations, that can credibly account for the recent warming!





So: can we make attribution of the change:

Model based studies

Simulate the climate without the human contribution, and then with human contribution. Compare to observed

From Stott et al, 2005.

A unique response

There has never before been seen in science:

Such a scale of multi-disciplinary research on one theme

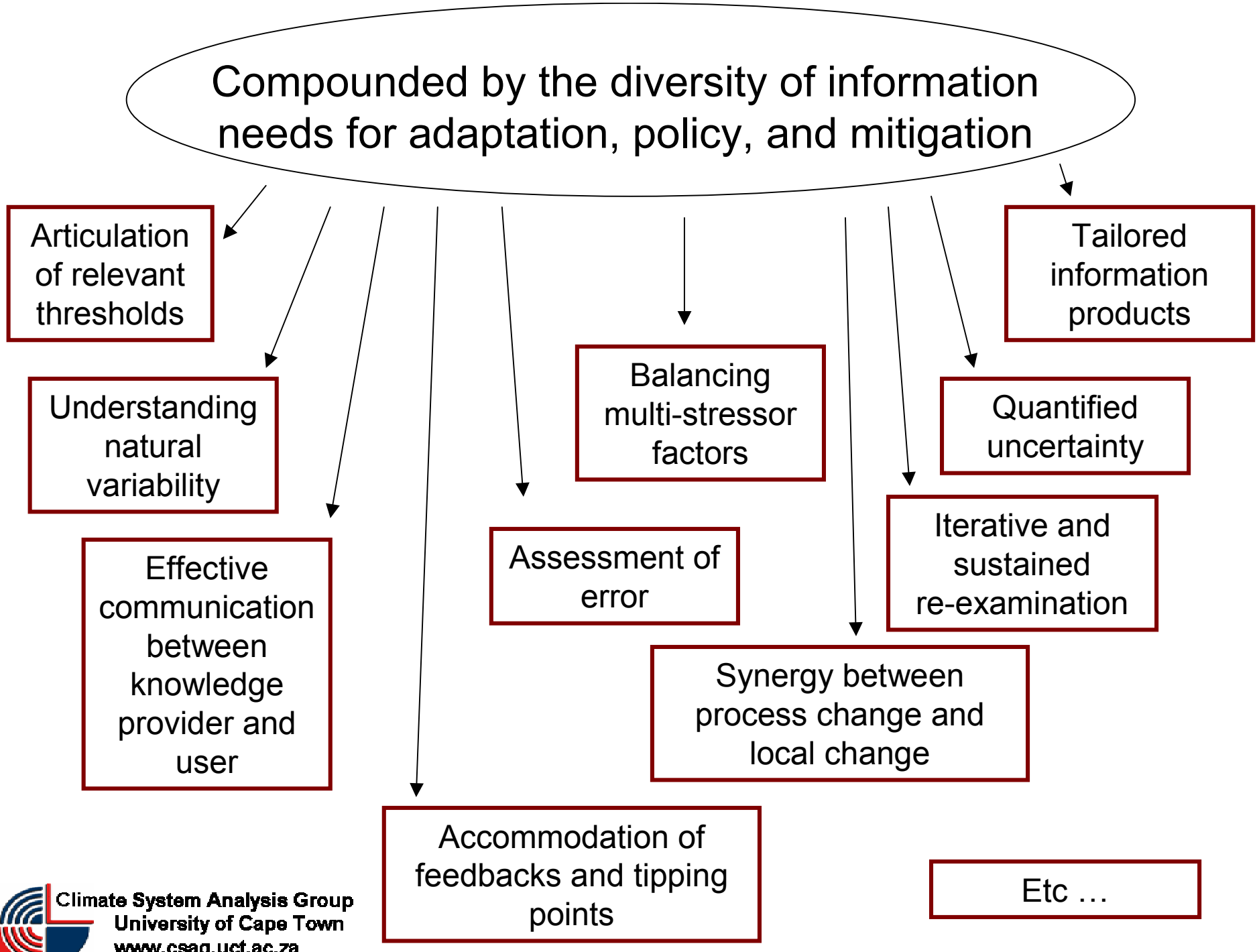
The magnitude of international collaboration as is now occurring

The rapidity of release of new findings directly to society

An urgency of demand from society as we now see

The inadequacy of scientists to communicate, or society to adopt

A global challenge of such importance



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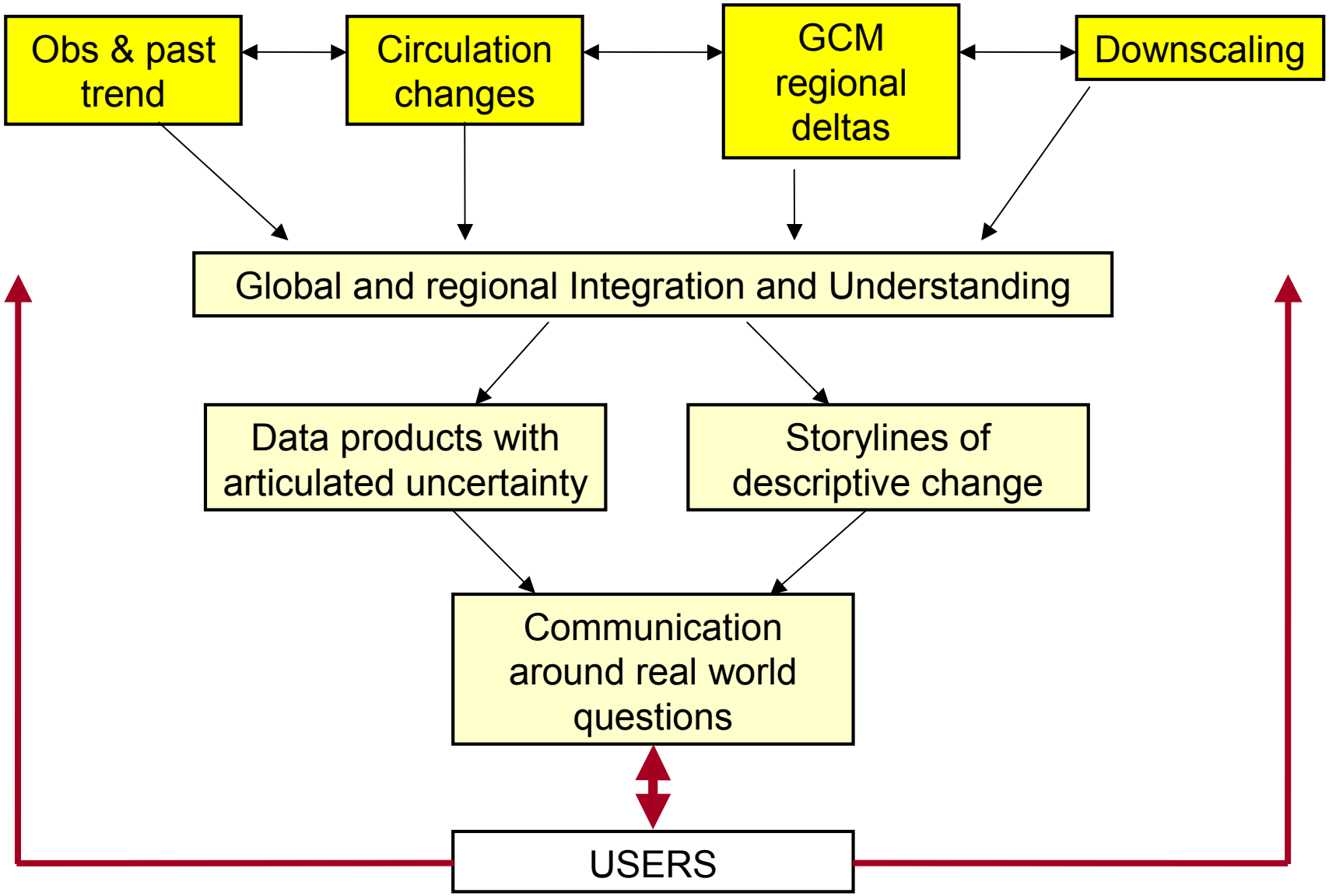

The foundation of understanding

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Looking to the future

There is an unavoidable level of commitment

Current emissions scenarios put us on course for 4 degree global mean warming by 2100

Mitigation can at best cap the magnitude
Adaptation is (context dependent) an essential

The worlds nations are making exceptionally large funding commitments

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Using and abusing projections to reach a range of variable outcomes

Can regional projections be

Credible

Defensible

Actionable

Data

↓

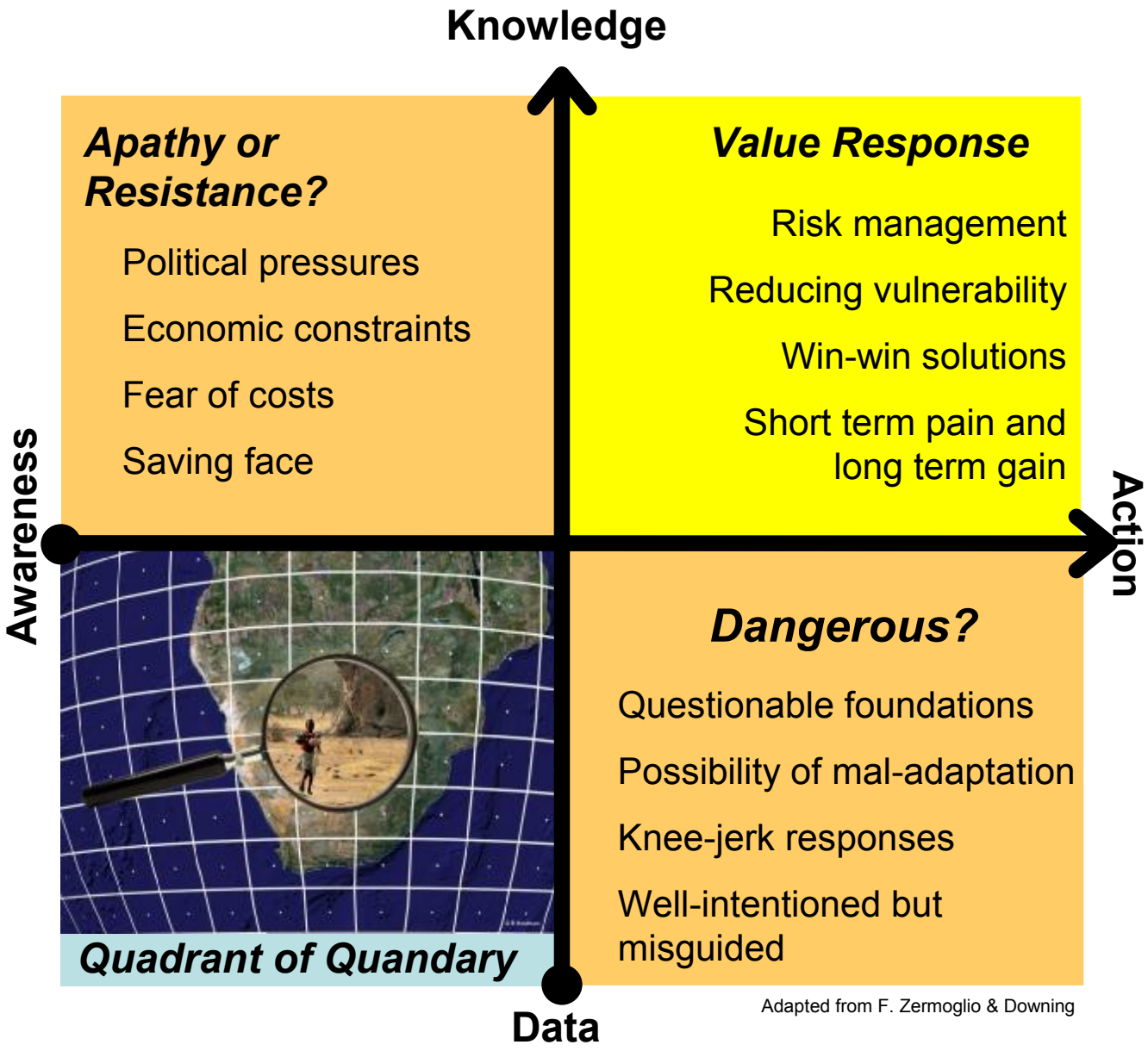
Information

↓

Knowledge

↓

Wisdom of action

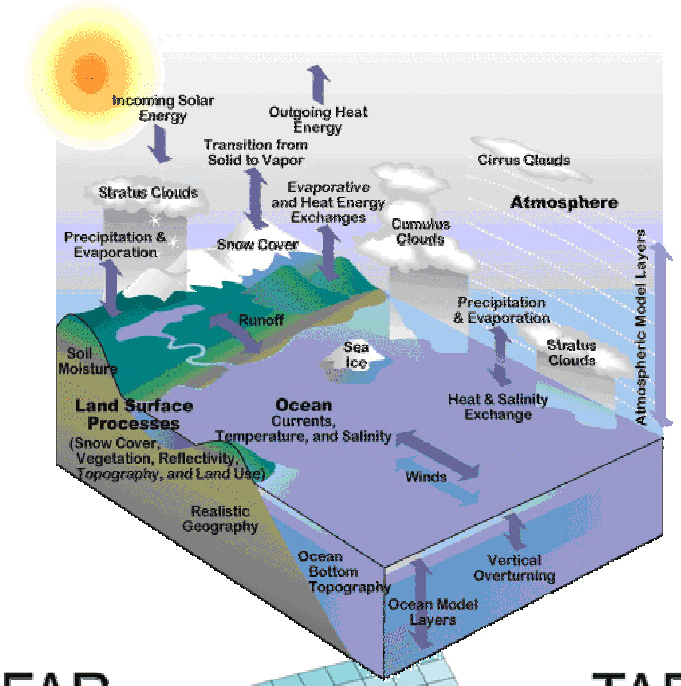


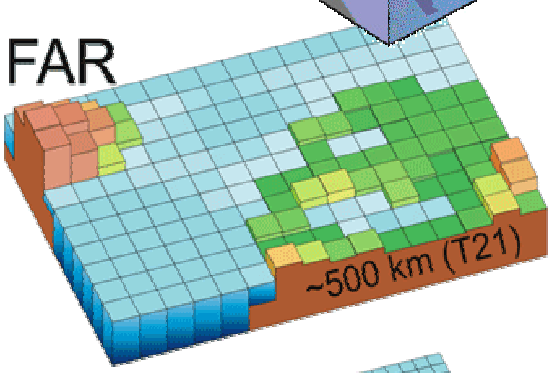
Adapted from F. Zermoglio & Downing

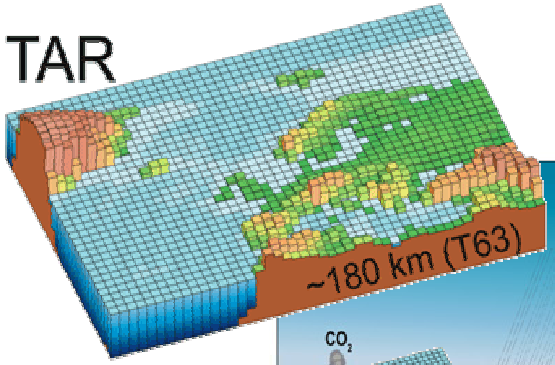
The computational simulation basis of climate projections

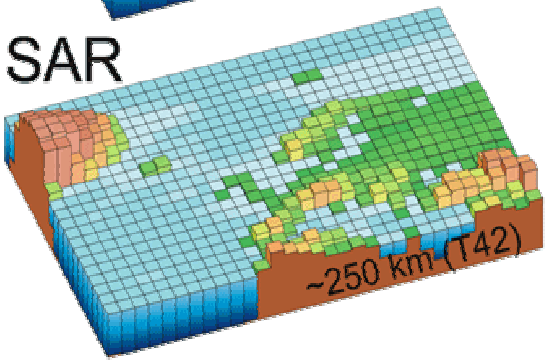
First order response is a robust determination largely unchanged since the late 1800s!

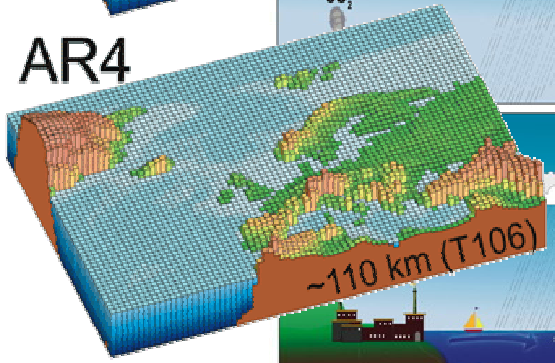
~1.5°–4.5°C for 2 x CO_2

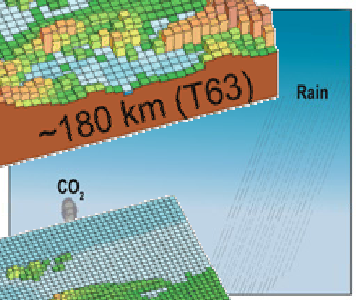


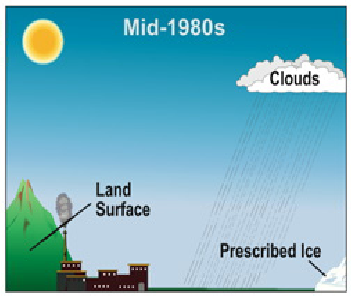


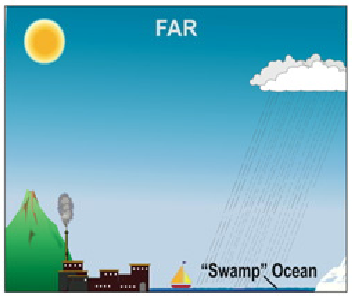


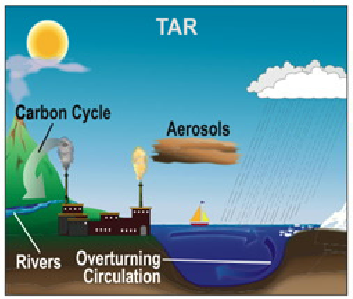


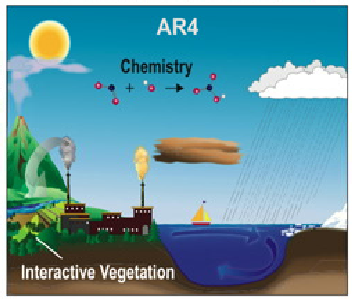


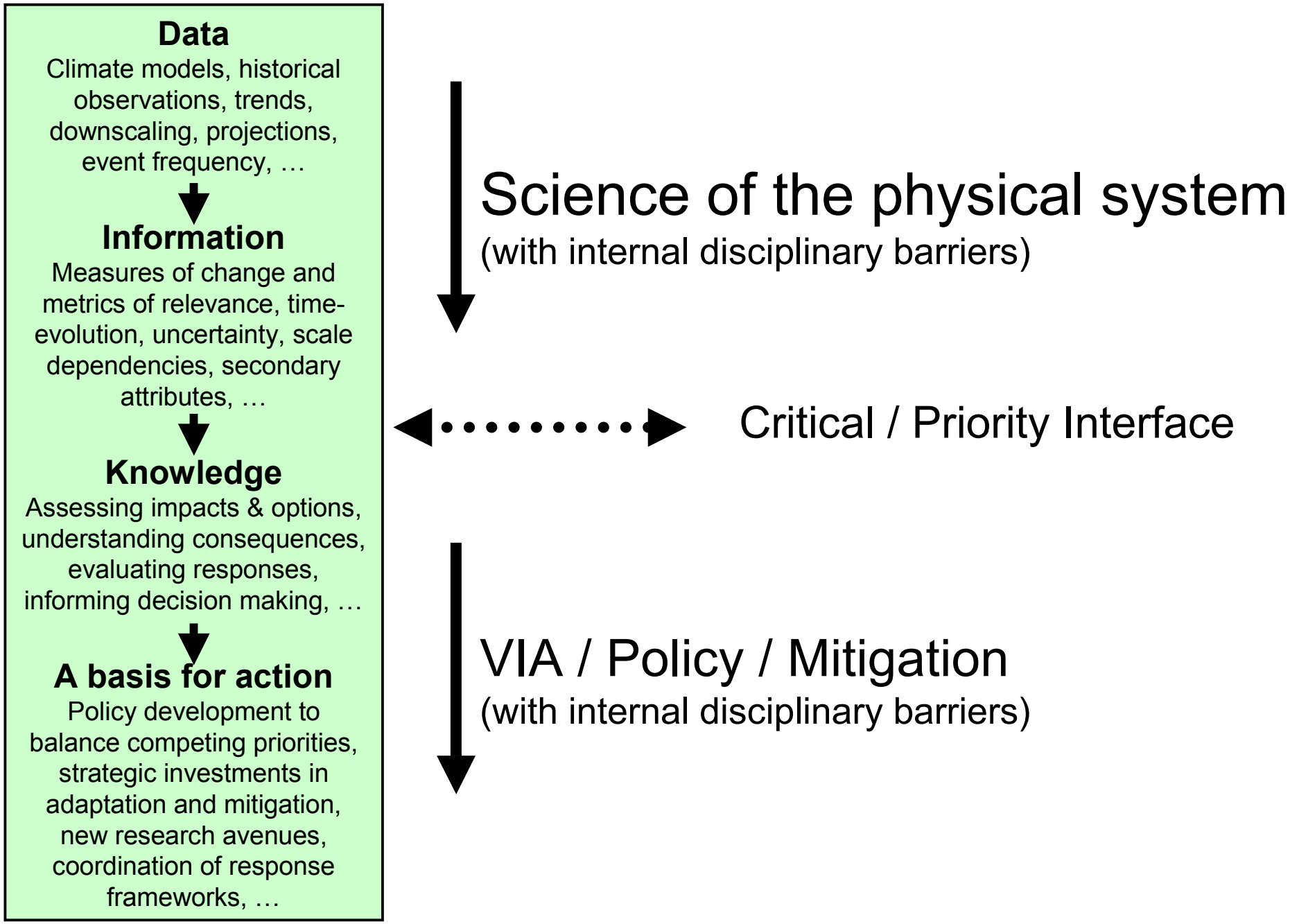


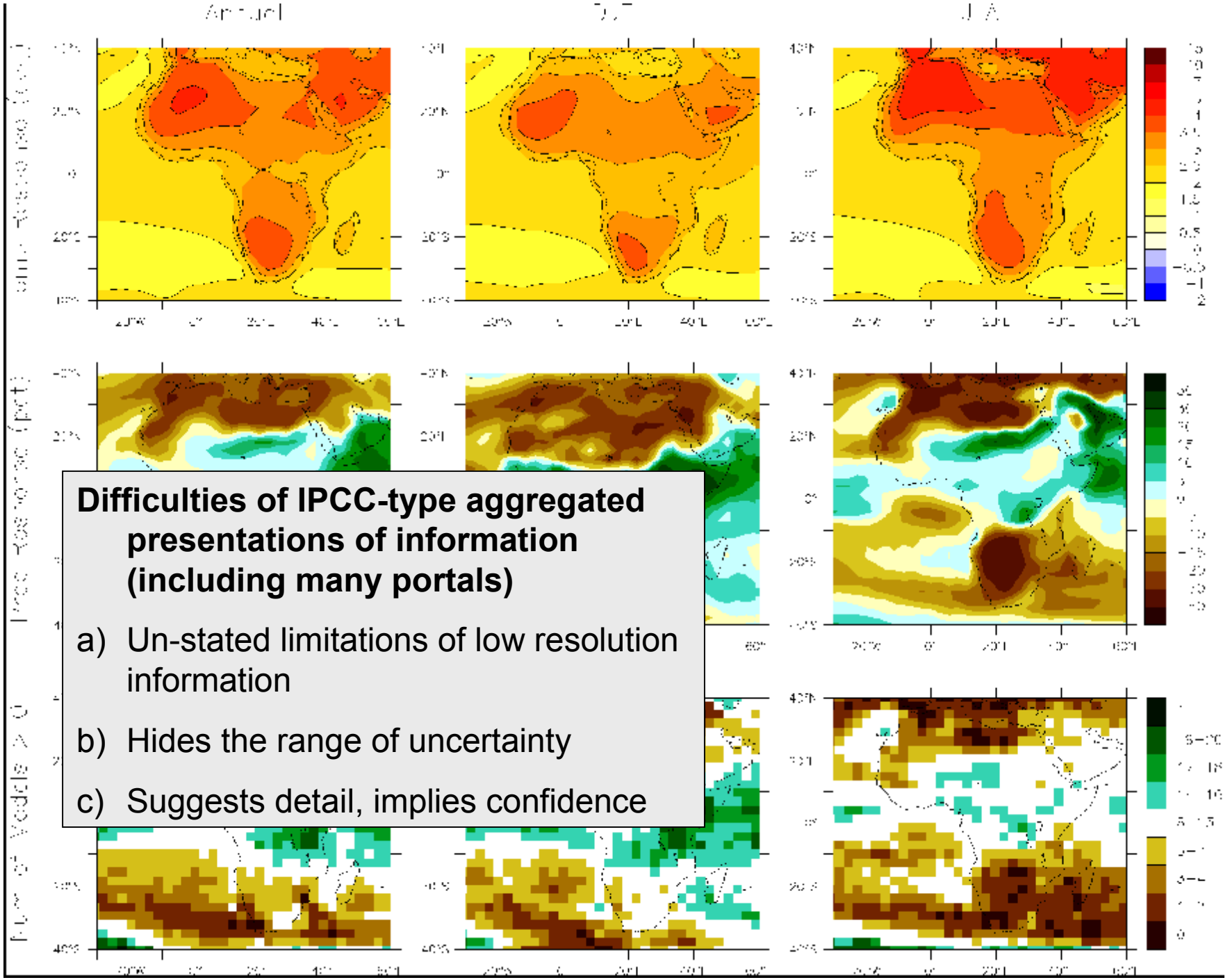









Data
Climate models, historical observations, trends, downscaling, projections, event frequency, …
Information
Measures of change and metrics of relevance, time-evolution, uncertainty, scale dependencies, secondary attributes, …
Knowledge
Assessing impacts & options, understanding consequences, evaluating responses, informing decision making, …
A basis for action
Policy development to balance competing priorities, strategic investments in adaptation and mitigation, new research avenues, coordination of response frameworks, …
Science of the physical system
(with internal disciplinary barriers)
Critical / Priority Interface
VIA / Policy / Mitigation
(with internal disciplinary barriers)



Difficulties of IPCC-type aggregated presentations of information (including many portals)

a) Un-stated limitations of low resolution information

b) Hides the range of uncertainty

c) Suggests detail, implies confidence

AR4 Ch 11

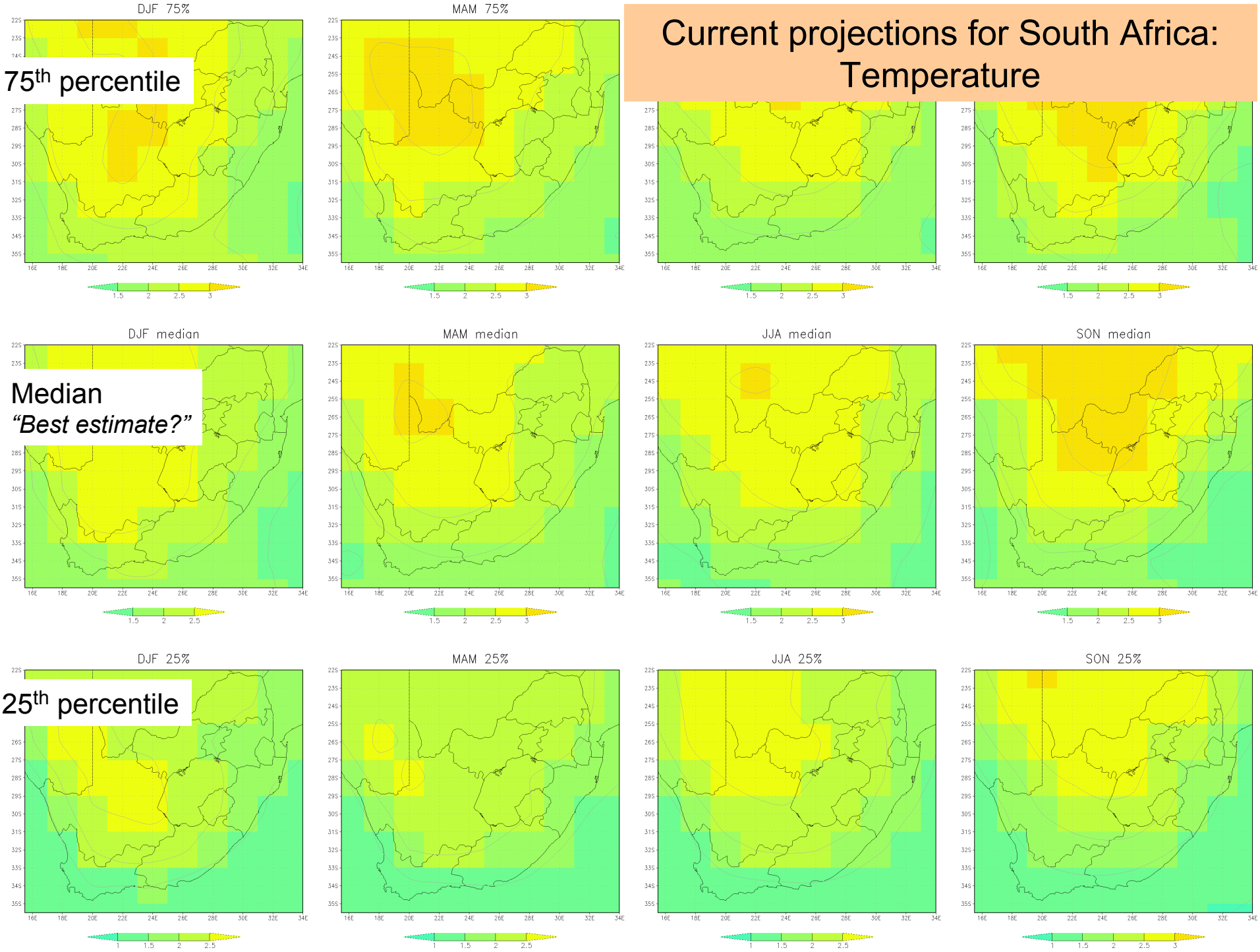
Rainfall(%)/Temperature changes by end of 21st Century

Current projections for South Africa: Temperature

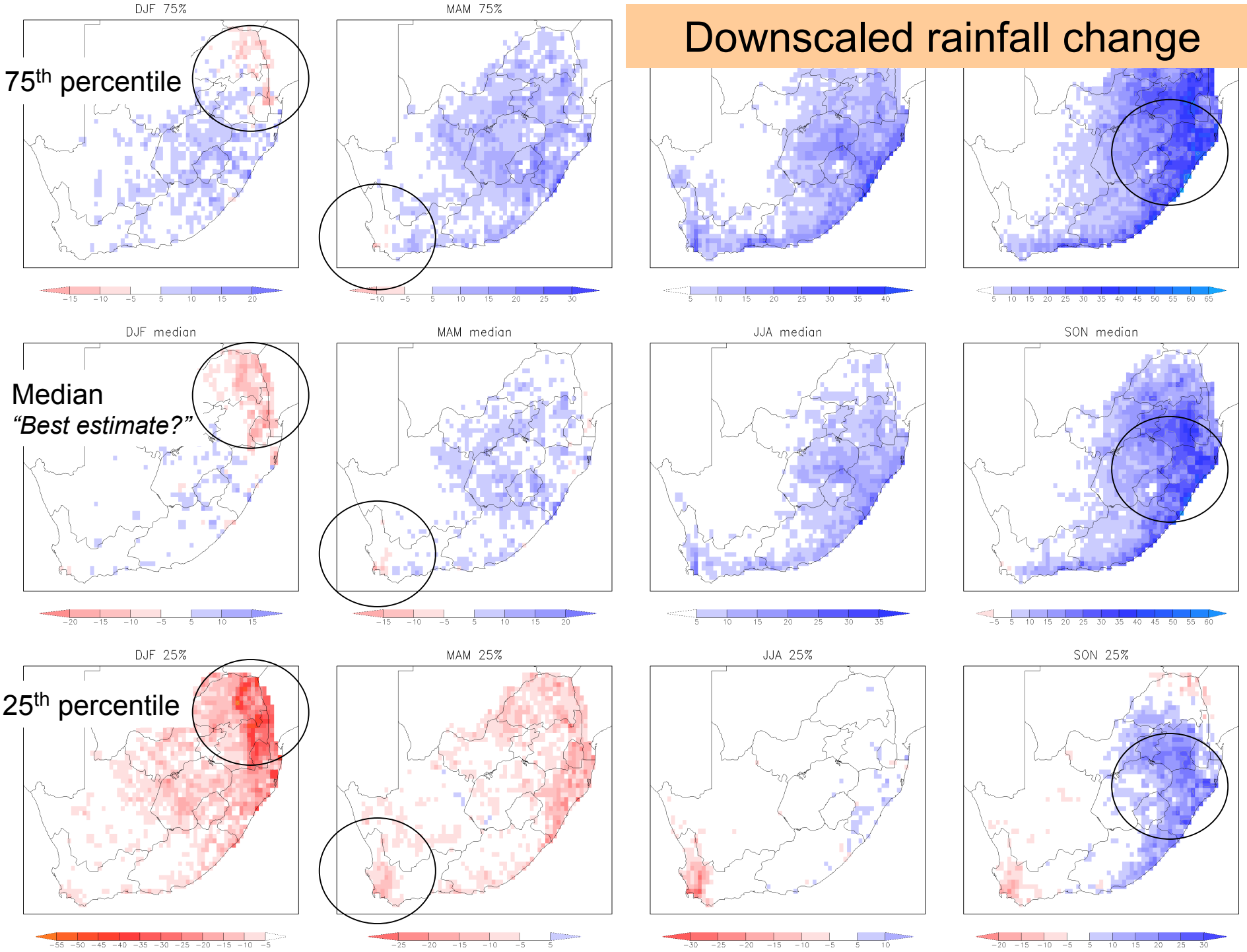
75th percentile

Median
"Best estimate?"

25th percentile



Downscaled rainfall change



Sampling the “opportunity-space”

Research:

- New multi-disciplinary frontiers
- Innovation of applications (e.g. GRACE satellite)
- Capacity building in developing nations
- Enhanced understanding of the coupled system dynamics

Society:

- Changes towards sustainable living (30 planets needed for USA lifestyle)
- Investment in poverty alleviation and development
- Realignment of values and political power
- Leap-frog technology

Economic:

- New markets with different technologies
- Changing frameworks for improved resilience

Adapting to “climate change” … means adapting to what?

Pick as role as a stakeholder trying to accommodate climate change

What has already changed?

Is that any different from variability?

What is the future?

When is the future?

How do you know that?

Where do you get your information?

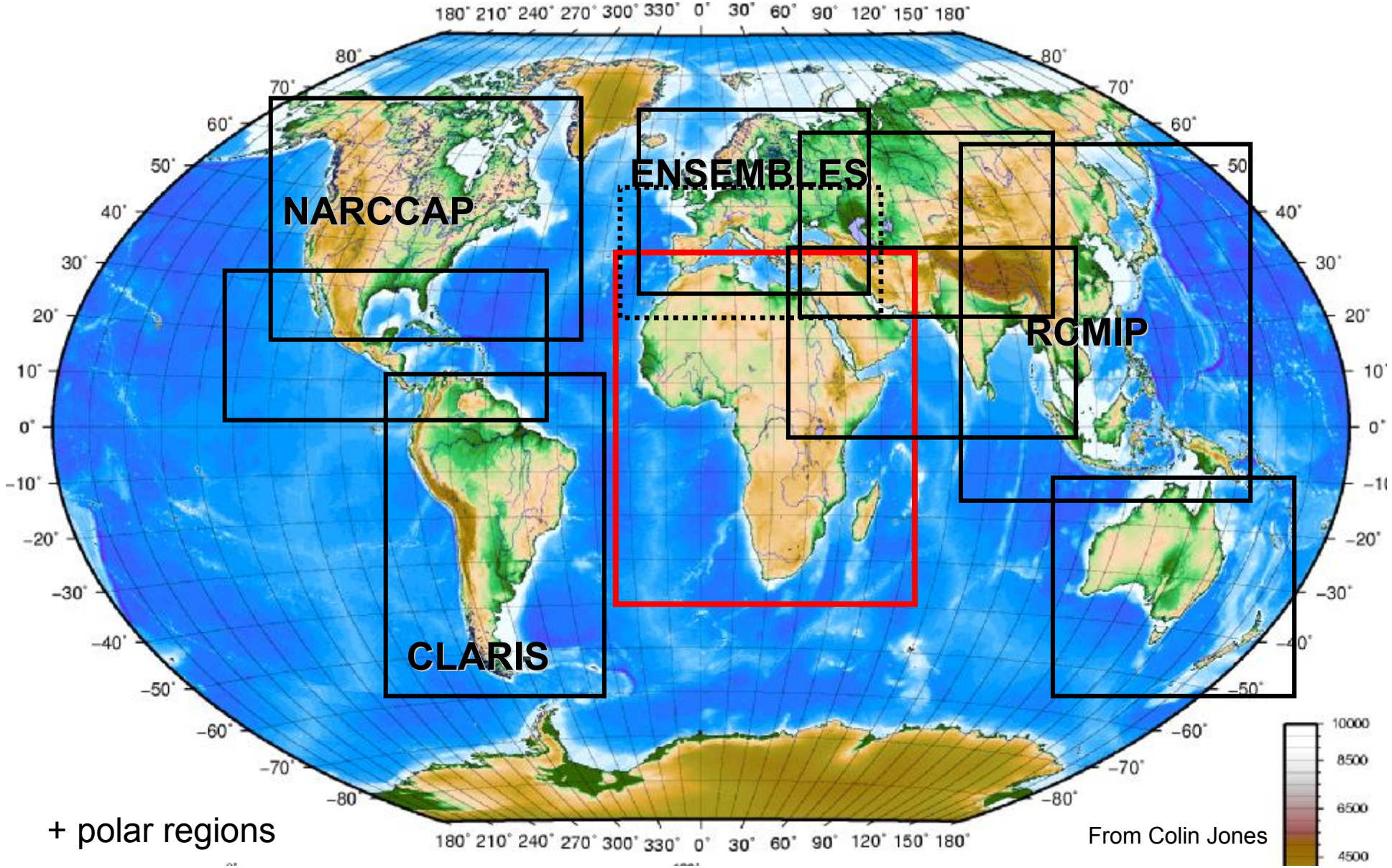
Do you “believe” it?

How do you know how good it is?

Would you spend your **own** money based on this information?

At the root of the issue, do you know threshold of vulnerability?

New developments: changing the game plan of information



+ polar regions

From Colin Jones

Going further: starting points

Main reference:
The IPCC 4th assessment report: http://www.ipcc.ch

Summaries:
The Copenhagen diagnosis: http://www.copenhagendiagnosis.org

The NOAA State of the climate report, 2009: http://www.ncdc.noaa.gov/bams-state-of-the-climate/2009.php

Web sources:
a) Climateprogress (http://www.climateprogress.com)
See esp: http://climateprogress.org/2010/04/14/the-complete-guide-to-modern-day-climate-change

b) Realclimate (www.realclimate.org)
See esp: http://www.realclimate.org/index.php/archives/2004/12/index/

The skeptics arguments:
Skeptical science (www.skepticalscience.com)
Also: iPhone and Android app of answers to skeptics arguments

Example of skeptical writing and the science rebuttal: Ian Plimer's book "Heaven and Earth"
See collation of responses on the missing science at http://www.realclimate.org/wiki/index.php?title=Ian_Plimer

"Apathy is a sort of living oblivion." Horace Greeley (1811-1872)