Show us the evidence
Climate change in Southern Africa

Bob Scholes,
Distinguished Professor of Systems Ecology, Global Change Institute,
University of the Witwatersrand
CSIR Research Associate

NSTF annual general meeting, 17 Nov 2017
‘...when you have eliminated the impossible, whatever remains, however improbable, must be the truth.’ *Sherlock Holmes*, in *Sign of the Four* (A Conan Doyle 1890)
Warming is observed nearly everywhere over 20\textsuperscript{th} C
Rainfall trends are weaker and less consistent

You can’t just take an average! They are first corrected for spatial, local and instrument biases.
People who thought they could do better ended up with the same result!

https://en.wikipedia.org/wiki/Hockey_stick_controversy
Temperature has mostly increased in South Africa - at about twice the global average rate!

1.5 °C/century vs 0.8 °C/century

Volksrust, Mpumalanga 1904-2014

- Maximum temperature: $T_{\text{max}}$ 0.53 °C/century $p<0.006$
- Minimum temperature: $T_{\text{min}}$ 2.44 °C/century $p<0.001$

Data: Mthokozisi Moyo and SA Weather Service

Long Term Adaptation Strategy 1, Figure 12&13
There are few statistically-significant annual rainfall trends in southern Africa (yet).

- Data: Mthokozisi Moyo and SA Weather Service

**Volksrust 1904-2014**
- 71 mm decrease per century
- \(p<0.16\)

The usual standard for science confidence is a less than 1 in 20 chance of being wrong (\(p<0.05\)). This is only a 1 in 6 chance. It will reach the threshold in about a decade.

Long-term Adaptation Scenarios 2013 Technical Report 1 of 6, DEA Pretoria
‘Detection and Attribution’

IPCC 5th Assessment Report glossary definitions

Detection of change is defined as the process of demonstrating that climate or a system affected by climate has changed in some defined statistical sense, without providing a reason for that change. An identified change is detected in observations if its likelihood of occurrence by chance due to internal variability alone is determined to be small, for example, <10%.

Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with an assignment of statistical confidence.

See IPCC AR5 WG1 chap 10 and WGII chap 18
The fingerprints of anthropogenic climate change

• **Exclude known causes** of climate variability: solar and orbital variation, volcanoes etc

• **Positive correlation with posited causes**, specifically greenhouse gas concentrations

• **Are there signals** predicted by an enhanced greenhouse effect, but not other plausible causes?
  – Night-time temperatures rise more than day-time, winters more than summers, interior > coast > oceans, (poles and subtropics) > (tropics and temperate), lower > upper atmosphere, higher storm intensity rather than frequency...
Running a virtual experiment
Since we only have one world, create others *in silico*
GHG forcing only
Natural+human
Natural + human

- Temperature anomaly (°C)

Year: 1860 to 2000

- Effective radiative forcing (W/m²)

2.1 W/m²

Natural only

- Temperature anomaly (°C)

Year: 1860 to 2000

- Effective radiative forcing (W/m²)

-0.2 W/m²

GHG forcing only

- Temperature anomaly (°C)

Year: 1860 to 2000

- Effective radiative forcing (W/m²)

2.3 W/m²

IPCC AR5 WG I fig 10.1, 10.5
The analysis can also be applied at regional scale.
Climate change-related impacts have been detected worldwide.
The longer and more complex the causal chain the harder it is to do clear attribution.
When is an extreme weather event attributable to climate change?

Climate is the *statistical average of weather*, so it is hard to say any singular event is due to climate change

- *but* a sequence of such events which differ statistically from a reference level can be confidently classed as change, *and*

- an individual event that is implausibly outside the well-defined historical range is likely to reflect climate change.

Tornado, Gauteng 27 Jul 2016
Photo: http://www.2oceansvibe.com
The 2015/16 El Niño, heatwaves and drought in southern Africa

• The 2015/16 El Niño was one of the strongest on record
  – During the period 1995-2013 the global mean air temperature varied, with no significant upward trend. The heat was being absorbed by the ocean during this time. The El Niño represents an oceanic adjustment.

• High temperature records were been broken all round the world. This is a combination of El Niño and the rising baseline
  – More-or-less equal contributions by both in Southern Africa

• El Niños have occurred for thousands of years. The pattern was quite predictable up to the early 1990s, but has changed since then. This consistent with climate change predictions, but does not constitute proof
  – We would need a whole run of such events to be sure
Who can you trust?
Denialists, sceptics and *bona fide* experts

- All scientists are trained to be sceptical, and climate scientists are no exception. Rules of evidence must be followed, and uncertainties acknowledged.
- ‘Climate denialists’ stick to their message regardless of the strength of evidence provided to refute it.
- How do you separate the legitimate from the misguided, mischievous and malicious:
  - Do they have qualifications and a track record in the field?
  - Do they offer verifiable evidence, or just assertions?
  - Do they publish in peer-reviewed journals?
  - Do they repeat long-disproven claims and conspiracy theories?