Potential risks and vulnerabilities to health under climate change

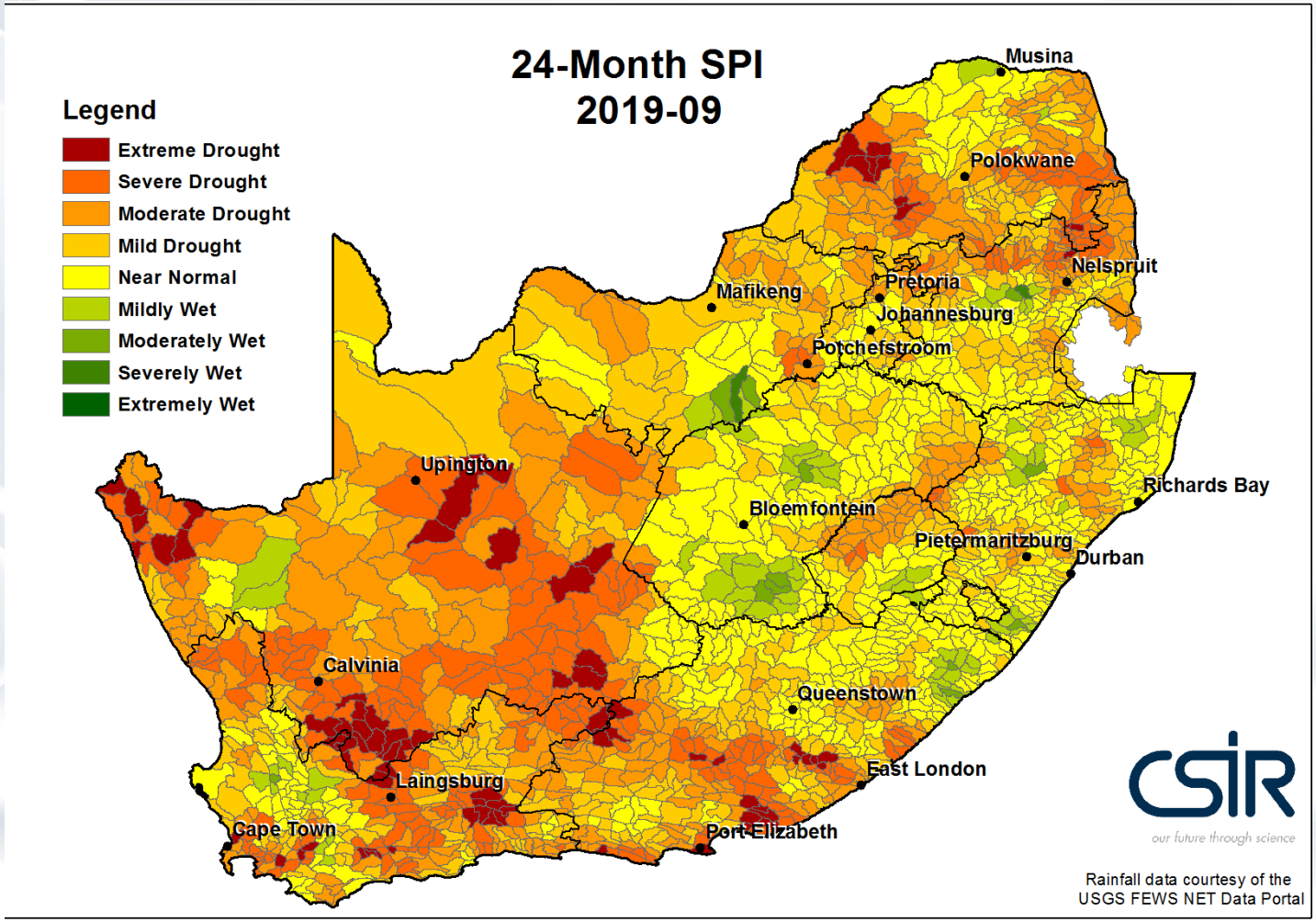
Media presentation by Johan Malherbe and Juanette John

CSIR Smart Places Cluster

Natural Resources, Enabling Infrastructure, Professional and Public Services Division

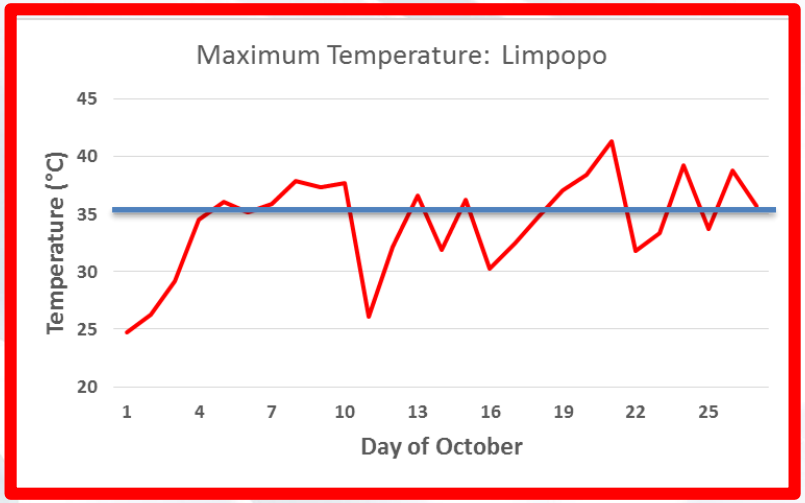
2-Year Standardised Precipitation Index

- Brown: Below-normal rainfall
- Green: Above-normal rainfall

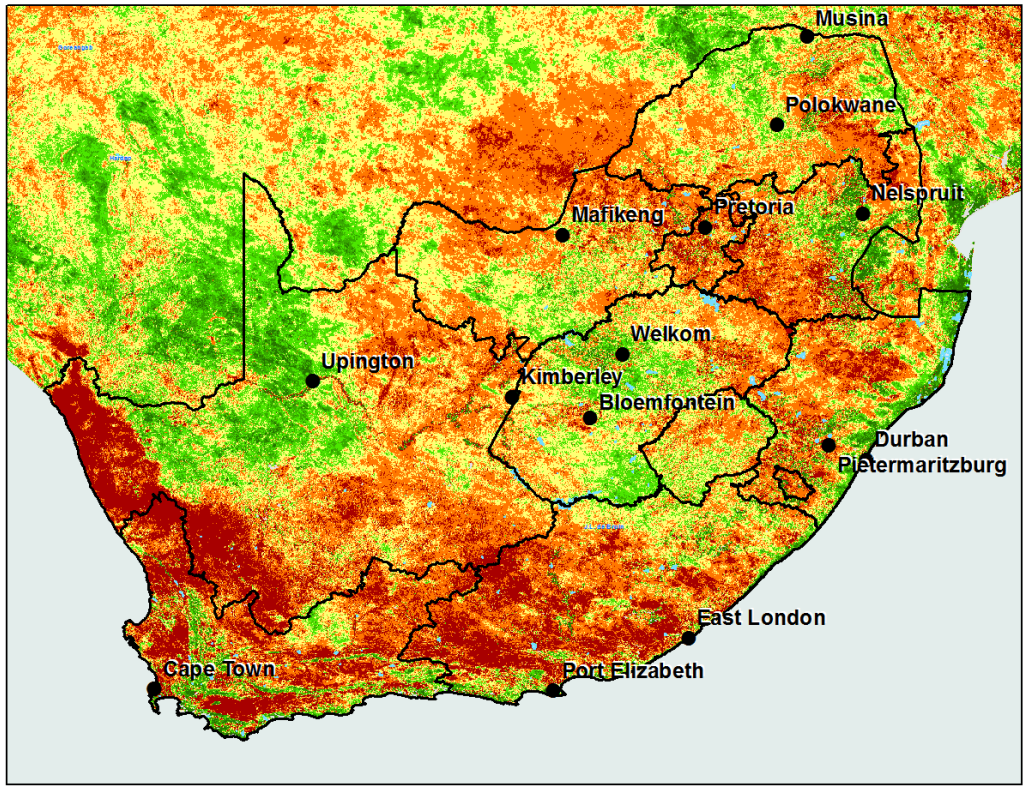


Current vegetation activity anomalies

- Brown: below-normal vegetation activity
- Green: Above-normal vegetation activity



Recent hot conditions



Legend

Province
VCI
0- 12
12 - 25
25 - 50
50 - 75
75 - 90
> 90
No Data

0 125 250 500 Kilometers

Vegetation Condition Index: 11 - 20 October 2019

Data courtesy of Copernicus Global Land Service, 2019. Distributed and produced by VITO NV, Belgium.

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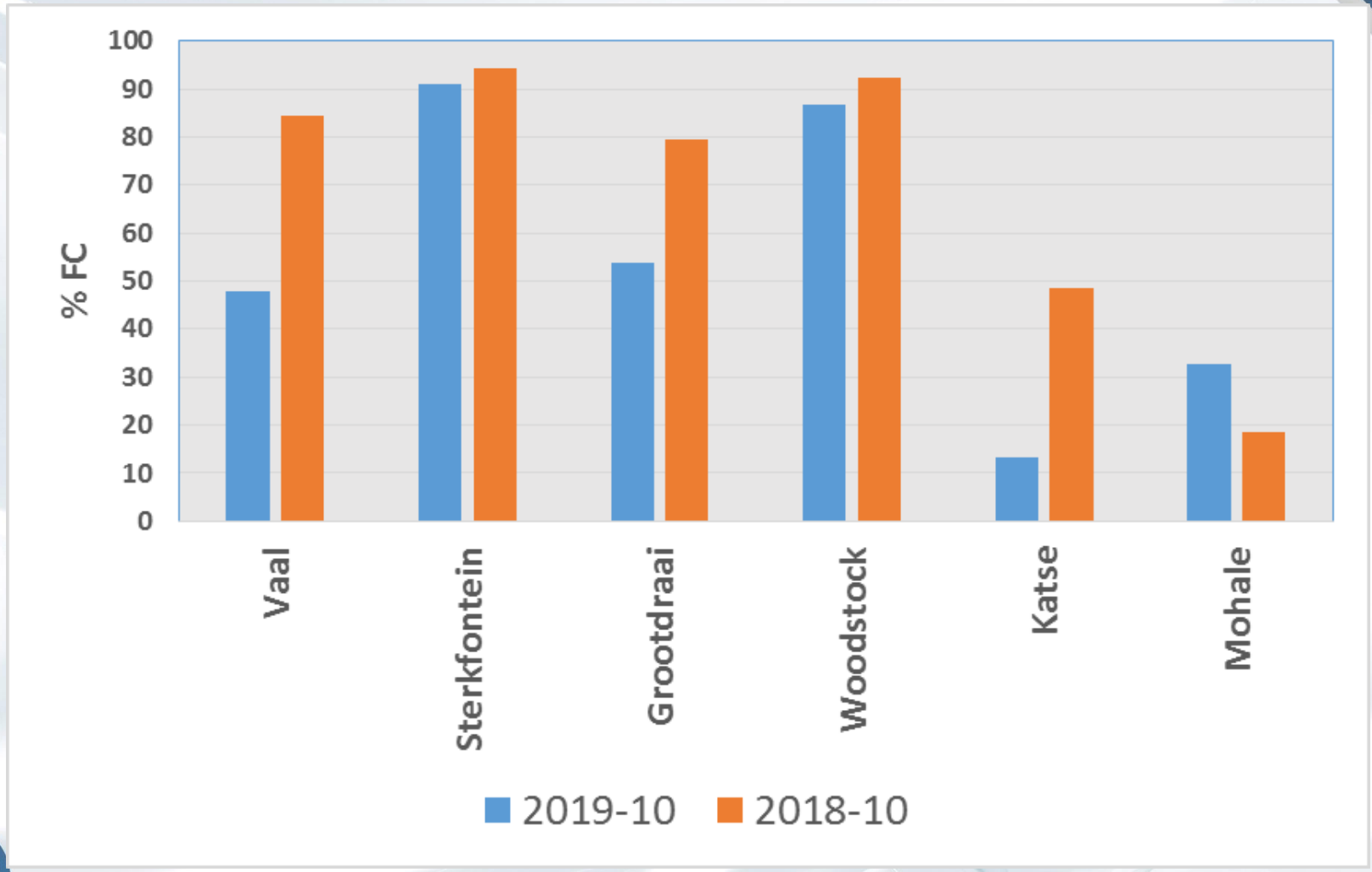
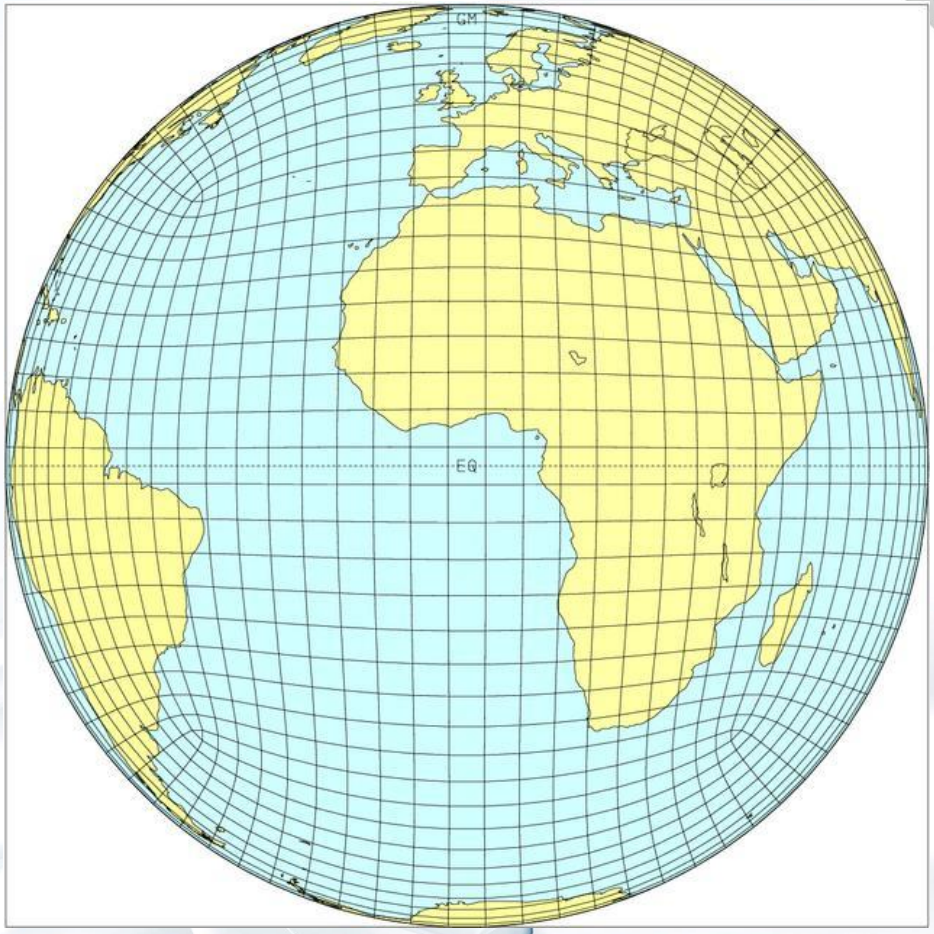
State of the Integrated Vaal River System



Data published by DWS; http://www.dwa.gov.za/Hydrology/Weekly

Global and regional climate modelling at the CSIR

- Modelling capacity build around the Conformal-Cubic Atmospheric Model (CCAM) of the CSIRO global model (McGregor, 2005)
- Multi-scale climate modelling
  - Working across timescales – weather (days lead time), seasonal (1-3 months lead time), climate change (until end of the century)
  - Regional and global modelling



Global and regional climate modelling at the CSIR

- Perform regional and global climate modelling
  - Working towards **improving representation of Africa** in global climate model that we run (CCAM)
  - Understanding **impacts and risks** of climate projections

- First research focus of our health impact work was on **increasing temperatures across Africa**

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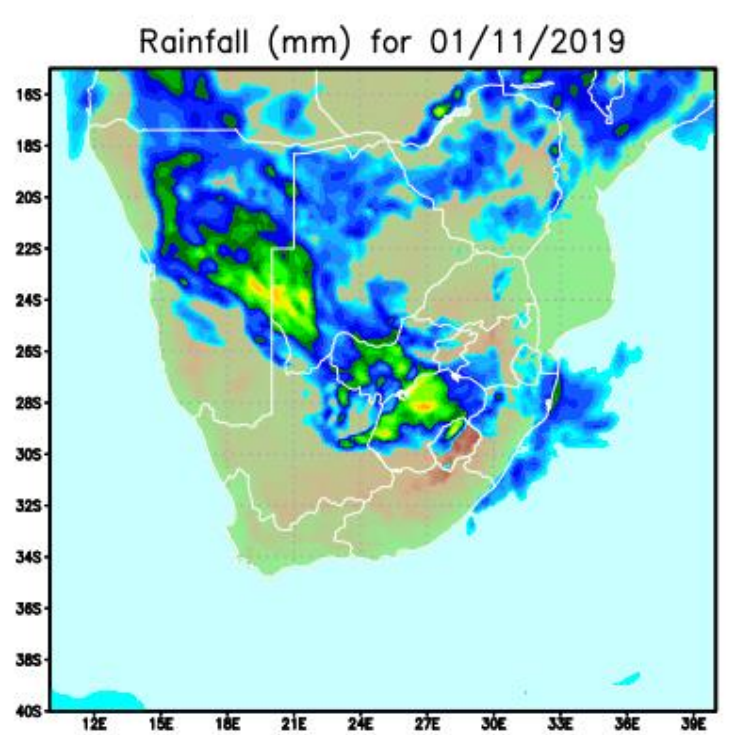
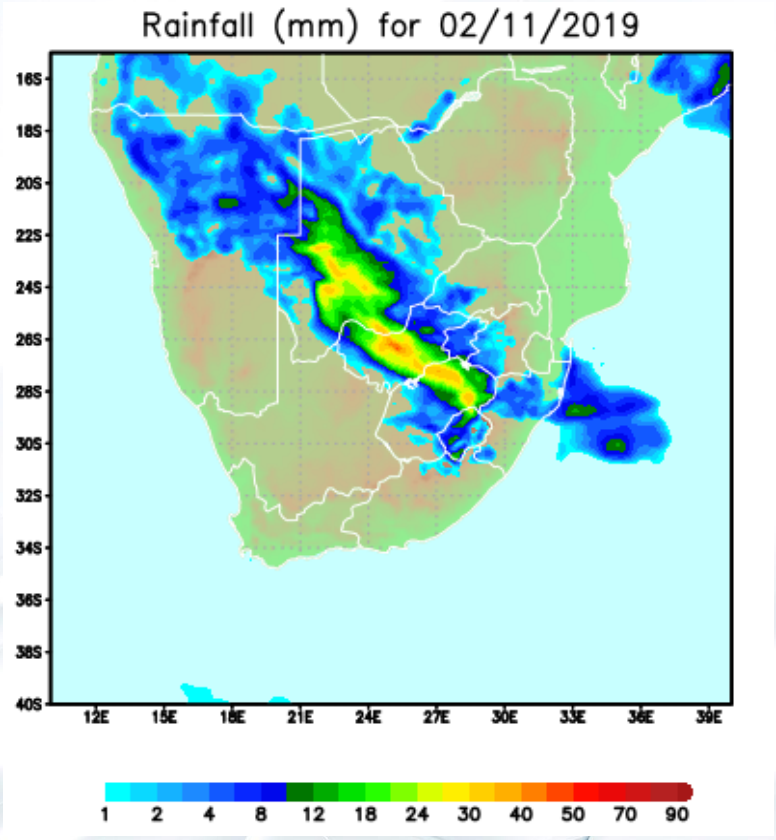
Short-term forecast

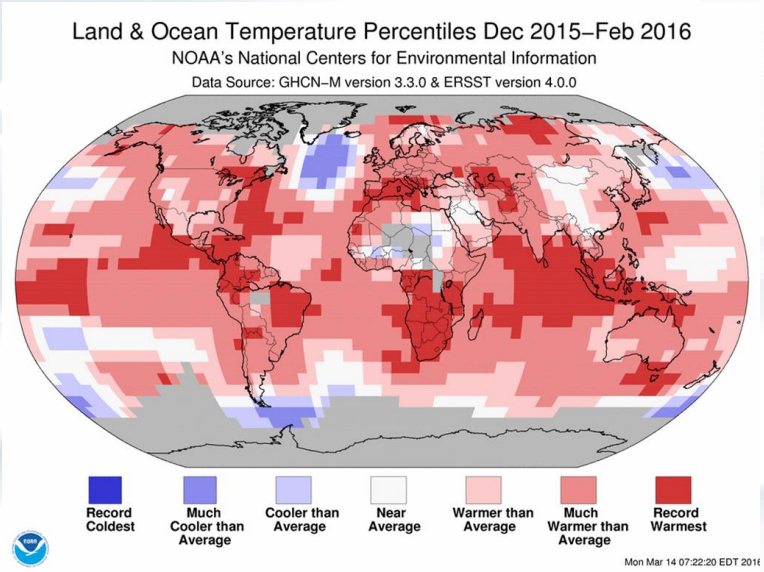
- **Widespread rain expected over parts of the maize-production region Friday/Saturday**
- **Recent hot conditions over for now**

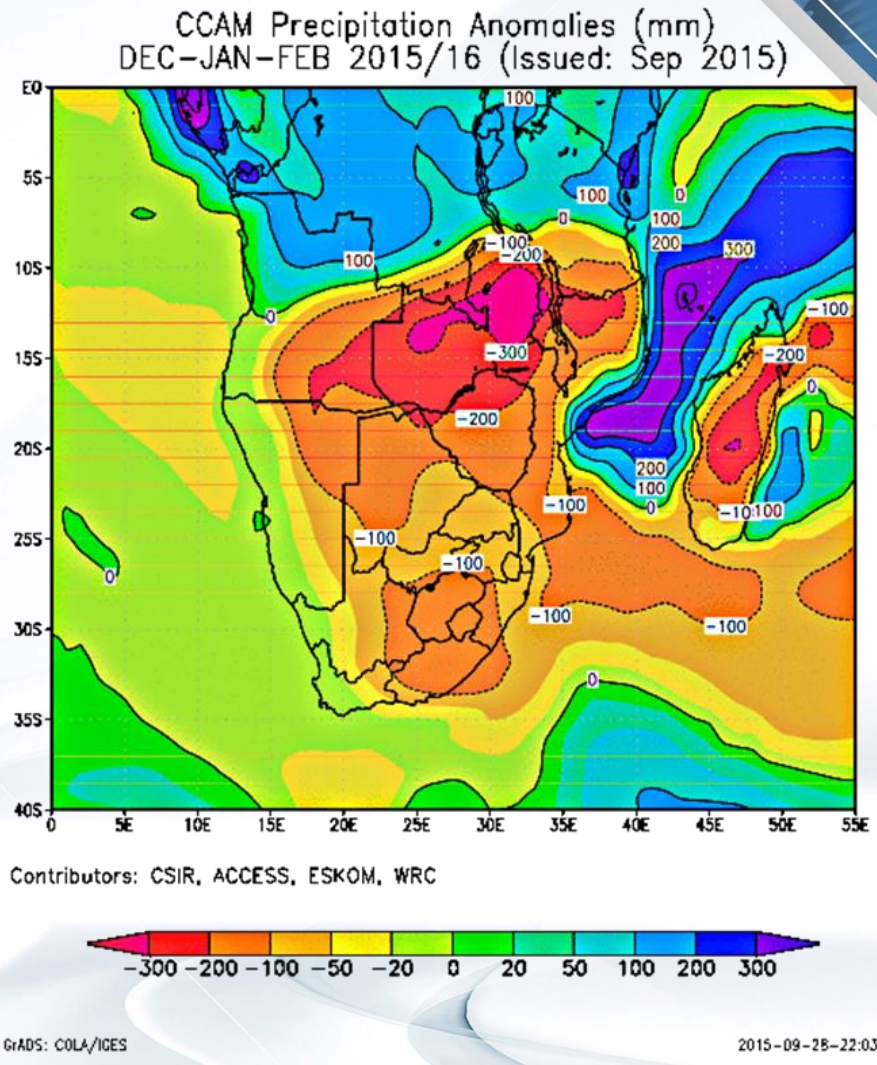




Seasonal forecasts

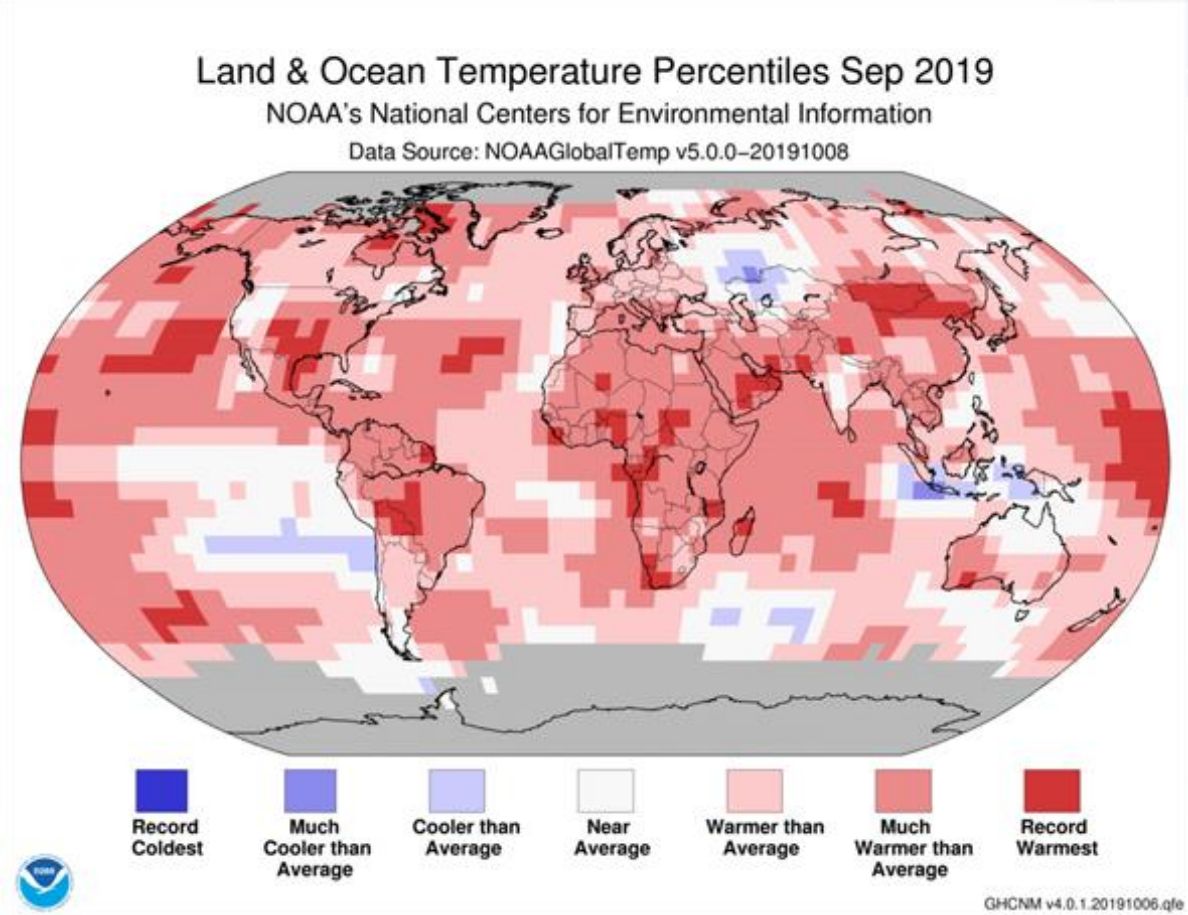
- No strong ENSO signal
- Relatively large spread in expectations
- Conditions towards mid-summer likely to improve





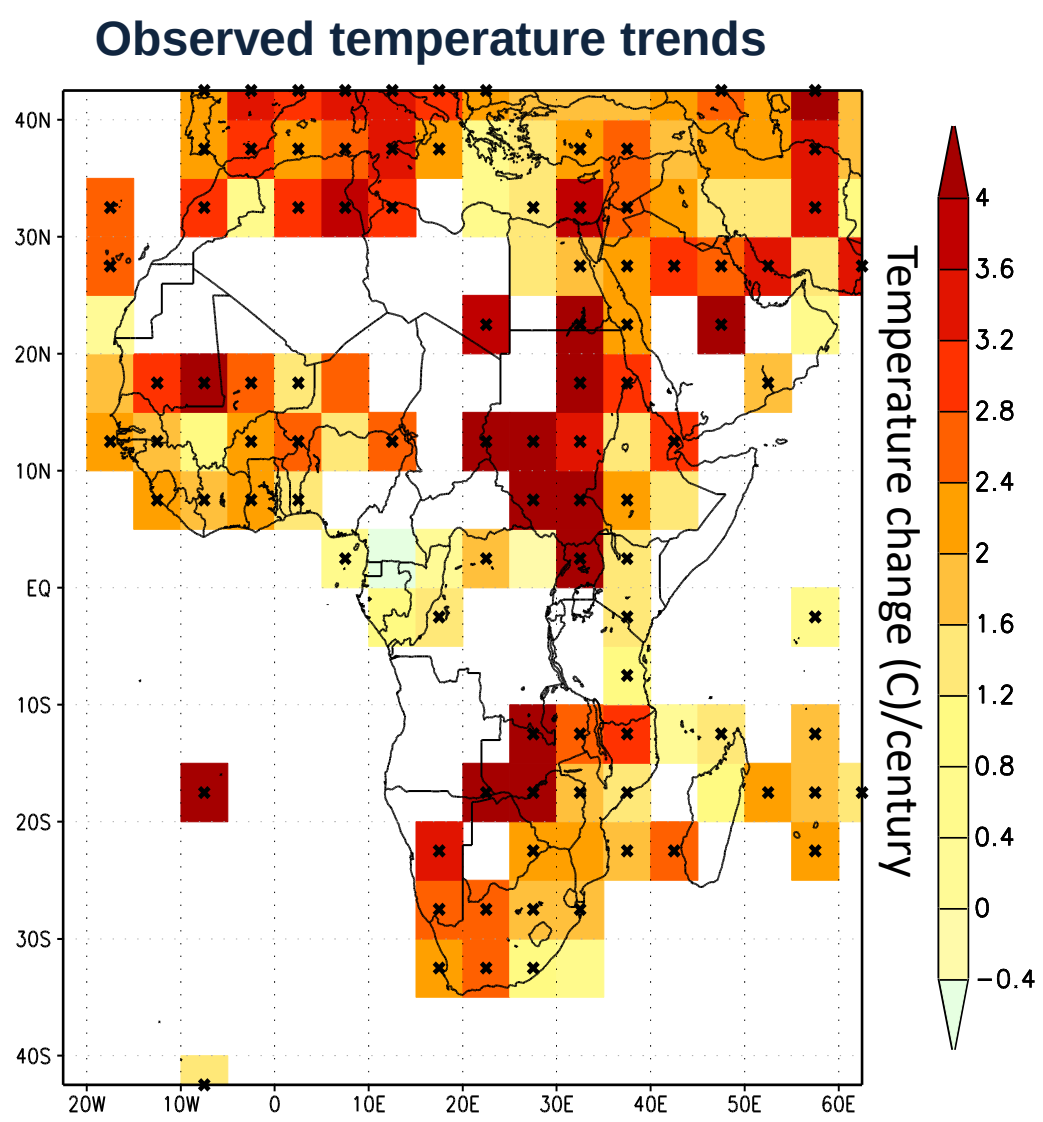
Climate change

- **September 2019: warmest on record**
- **2019 looking to be among the 5 warmest years in Earth's recorded history**
- **The six warmest years on record globally since 1880 will be the last six years—2014 through 2019—with the peak occurring during the strong El Niño year of 2016.**



https://www.ncei.noaa.gov/news/NOAA-Global-Temp-Dataset

Observed temperature trends in Africa



- **Global average** during same time **1°C/century** (pale yellow), **what did Africa look like in this time?**
- Much of Africa has experienced **larger rate of increase** than the global average (reds)
- Crosses mean increases were statistically significant.
- Already seeing warming
- Warming accelerating over southern Africa

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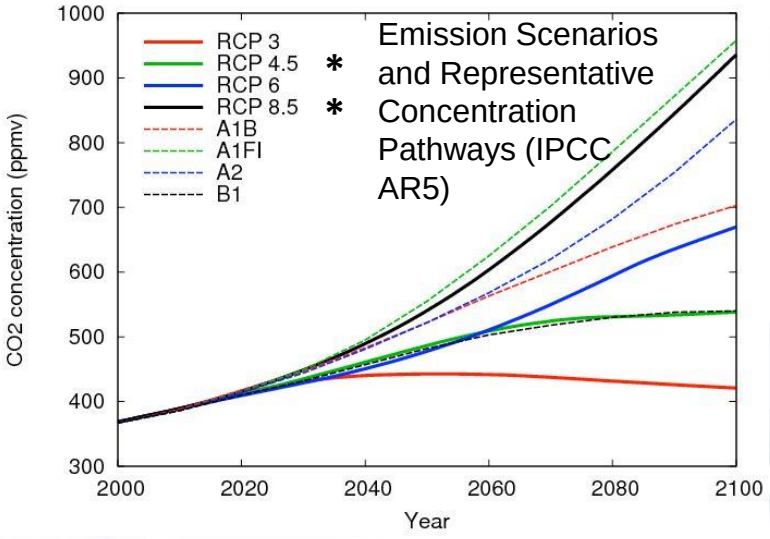
Simulated **annual temperature anomalies** relative to the 1971-2005 climatological average from CCAM.

Blues mean cooler annual temperature than reference period

Yellows and reds mean warmer annual temperature than reference period



Only RCP 2.6 can safely keep us well below 2°C above pre-industrial, whilst the world is currently between A2 and RCP 8.5

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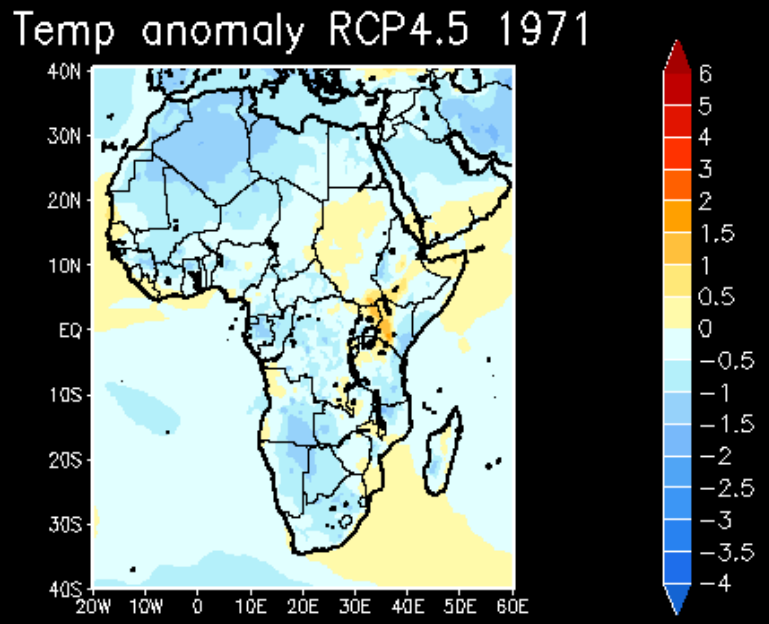
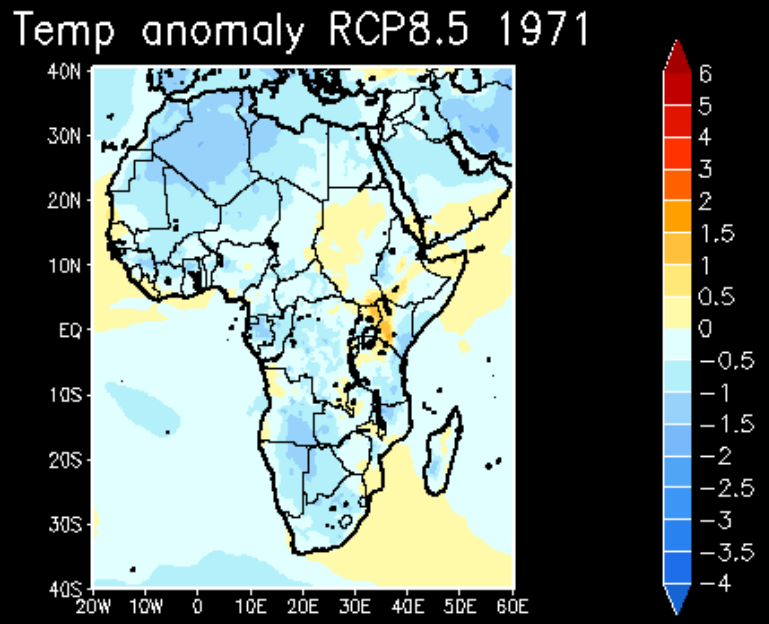
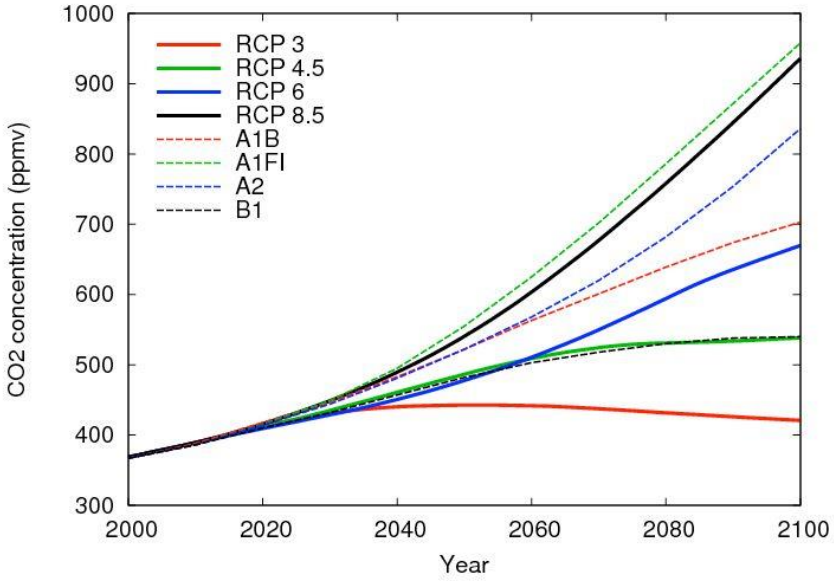


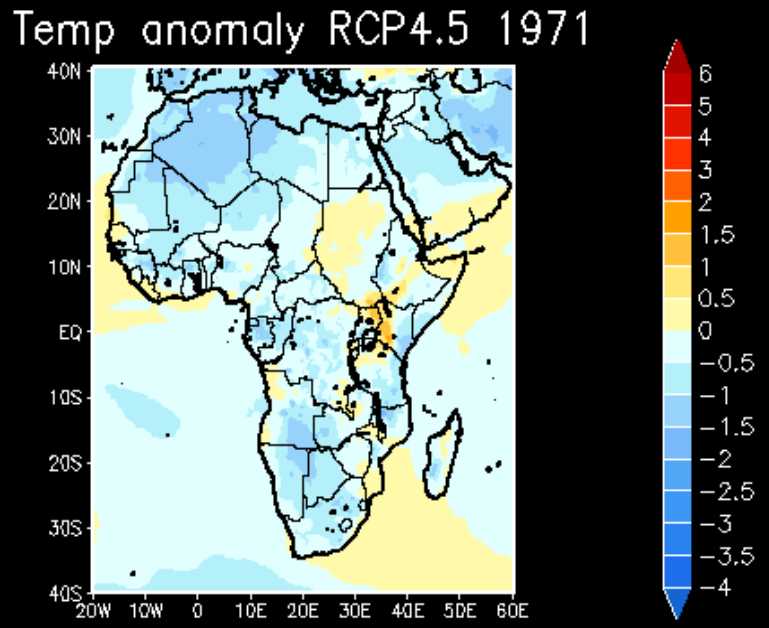


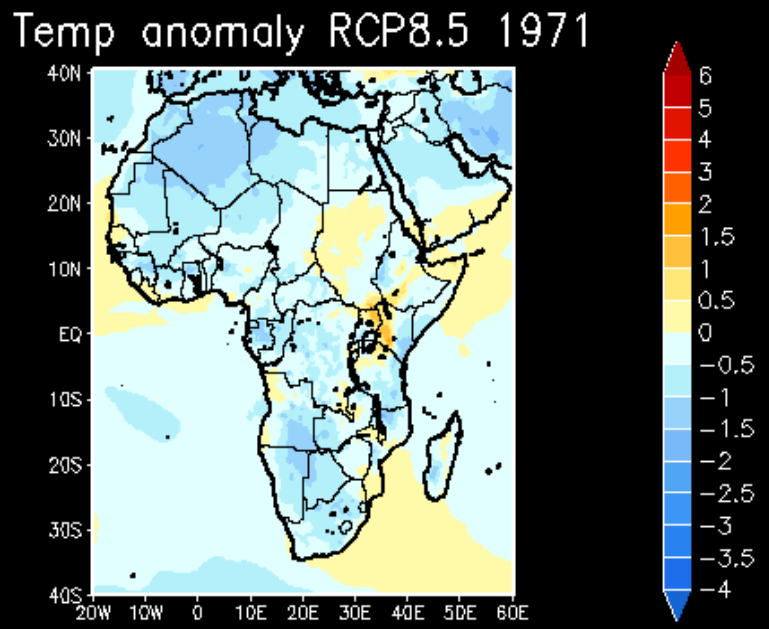
Highlighting differences in temperature anomaly for different emission scenarios

- RCP8.5 low GHG mitigation future
- RCP4.5 higher GHG mitigation future

CSIRO-CSIR collaboration: 0.5° resolution global climate change downscalings for CORDEX using CCAM
Downscaling six CMIP5/AR5 global climate models



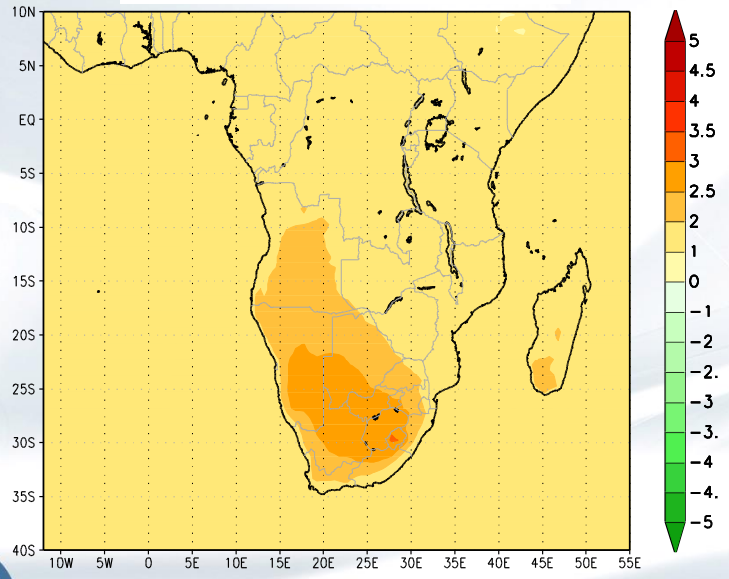




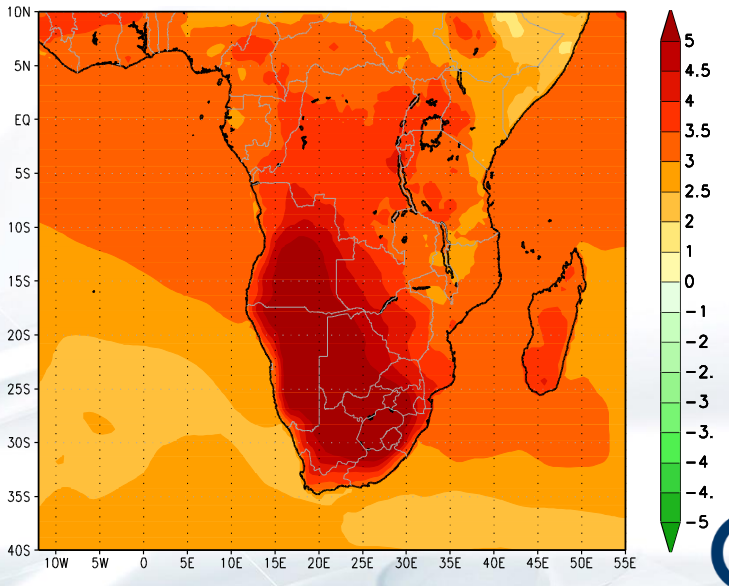
Projections of rapidly rising surface temperatures over southern Africa

- Assess signal across ensemble members (6 models)
- Climate change signals may be classified as:
  - **Plausible**
  - **Defensible**
  - **Actionable (robust)**
- …and form the cornerstone for climate services.
- The temperature signal is regarded as **actionable** (Engelbrecht et al., 2015).
- Figure shows the **projected changes in average temperatures** (degrees C) over southern Africa for 2080-2100 relative to 1971-2000 for RCP4.5 (left) and RCP8.5 (right)

Tave 50 perc RCP4.5



Tave 50 perc RCP8.5



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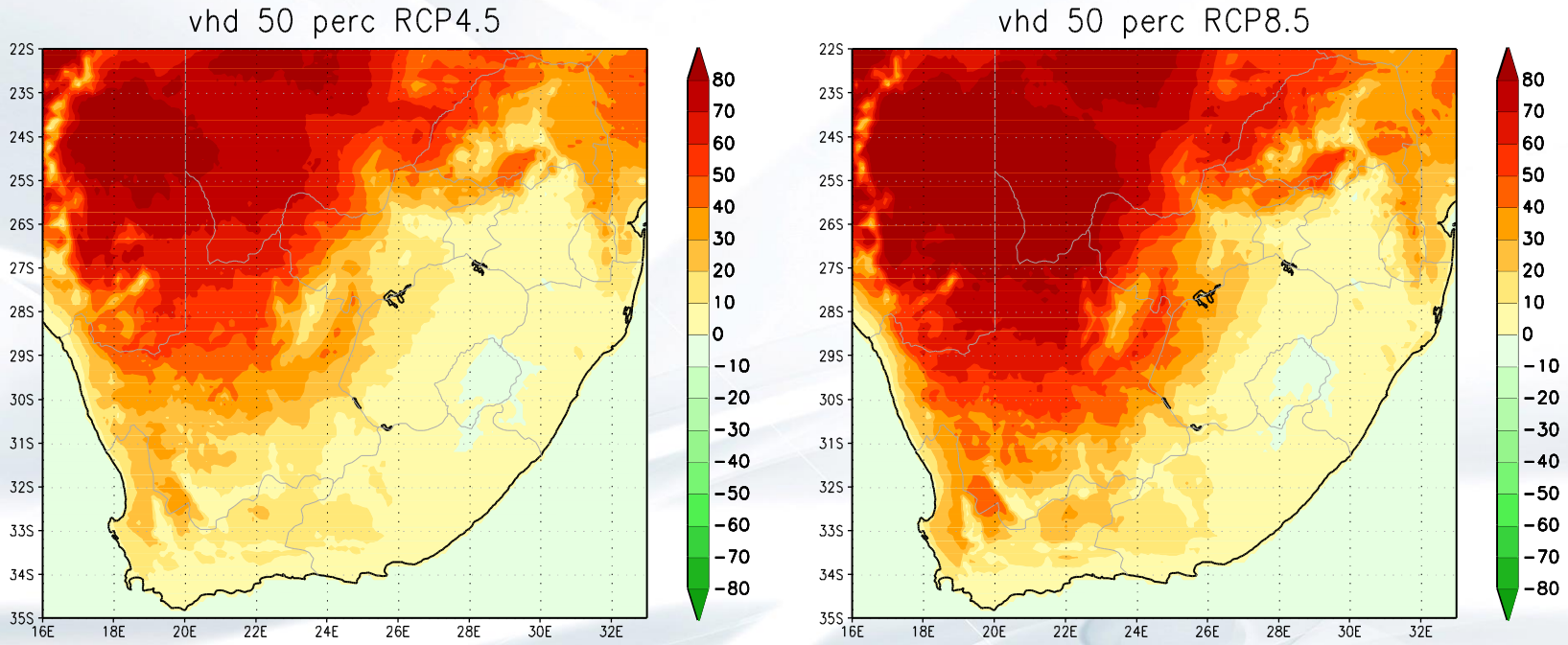
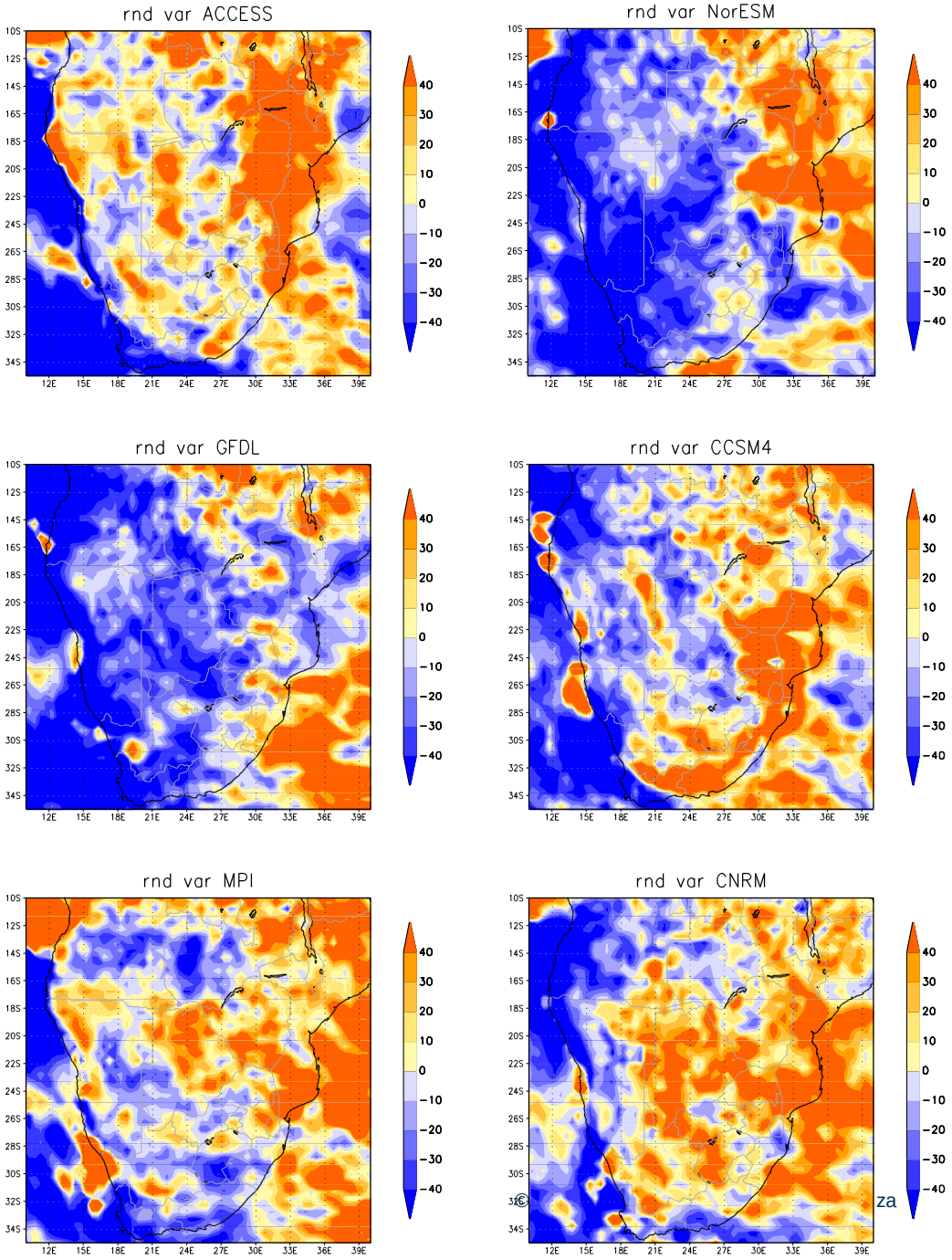
Projections of rapidly rising surface temperatures over southern Africa

Extreme temperatures

- CCAM projected change in the annual average number of very hot days (units are days per grid point per year) over South Africa at 8 km resolution, for the time-slab 2021-2050 relative to 1961-1990.
- The 50th percentiles are shown for the ensemble of downscalings of six GCM projections under RCP4.5 (left) and RCP8.5 (right).





Projected changes in the standard deviation of austral summer rainfall (mm) over southern Africa for the period 2071-2100 relative to 1971-2000.

The projections were obtained by downscaling the simulations of six different GCMs integrated under RCP8.5 to a high resolution global grid, using the variable-resolution atmospheric model CCAM.

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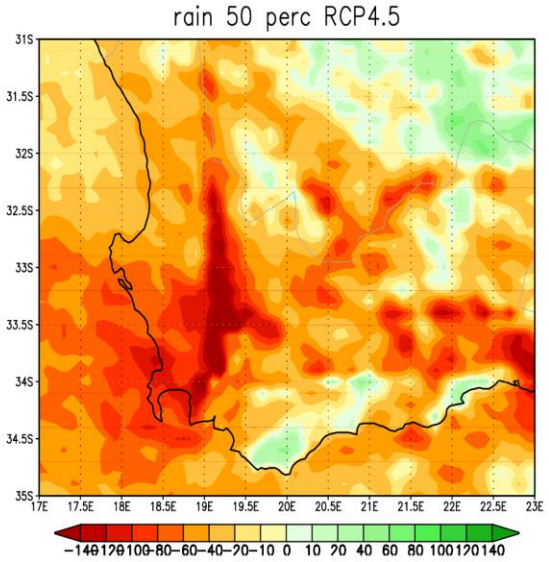
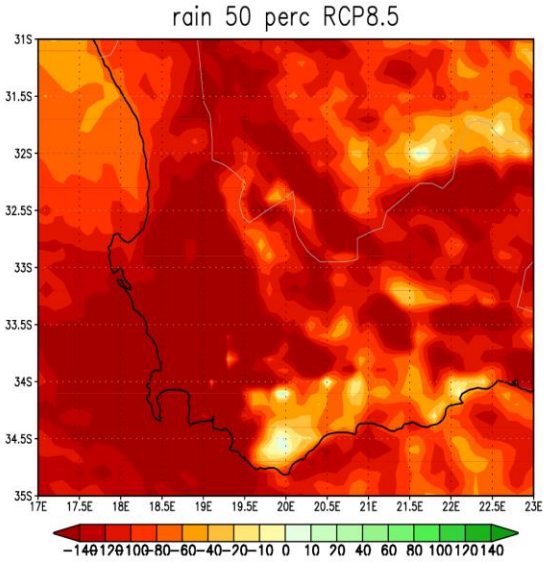
Drought in winter rainfall region of southern Africa





Projections of changing annual rainfall over the southwestern Cape for the period 1971-2099 relative to 1961-1990

- Does higher resolution impact on the projected climate change signal?

- How does the uncertainty range of the 8 km resolution projections compare to that of the forcing GCMs and the larger set of CMIP5 GCMs?

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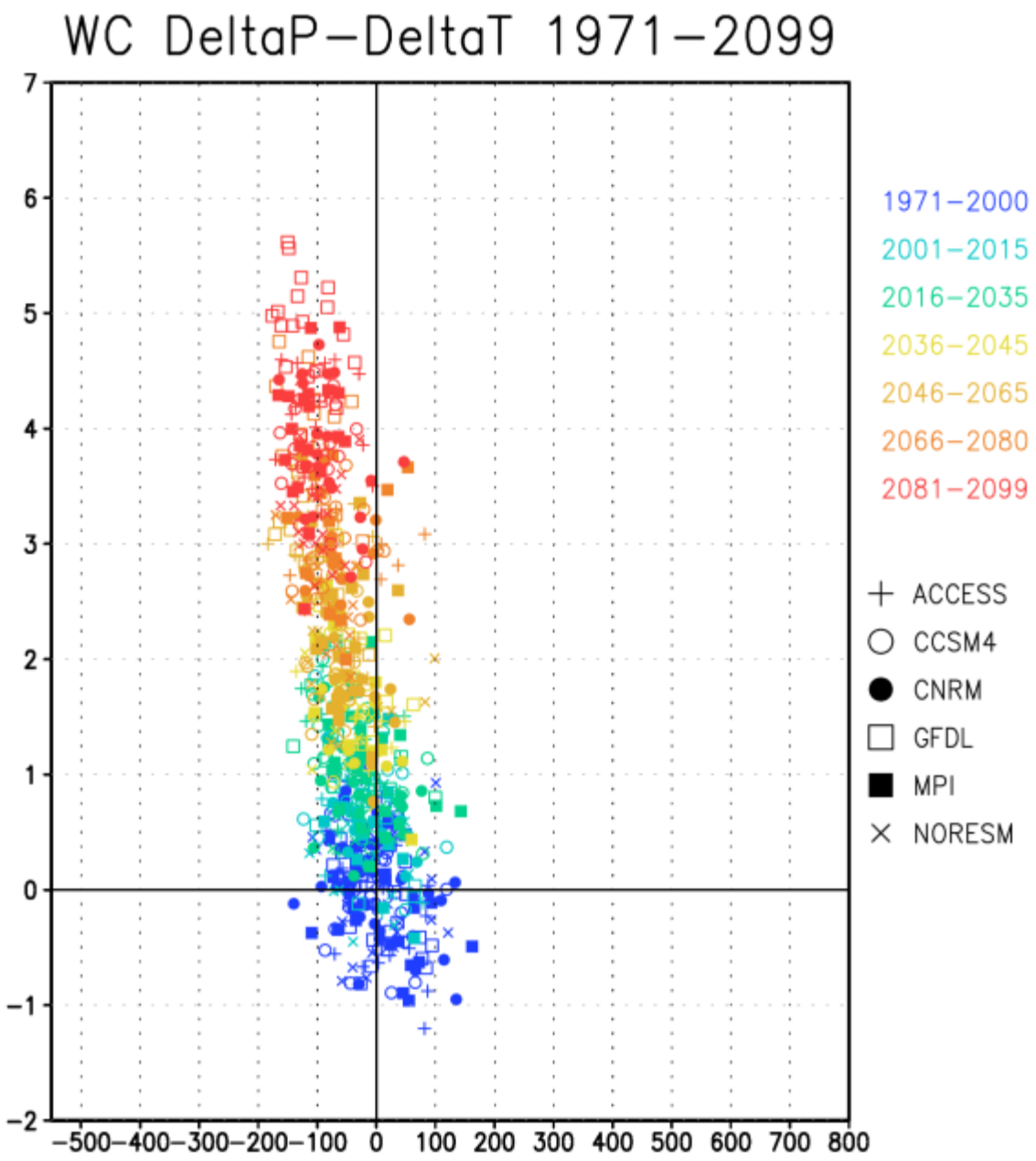

The southwestern Cape climate system is projected to drift into a temperature climate regime never observed in recorded history

Drastic temperature increases of 3-5 º C are likely by the 2081-2100 period under low mitigation

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Projected change in drought characteristics

Multi-year droughts projected to increase in frequency

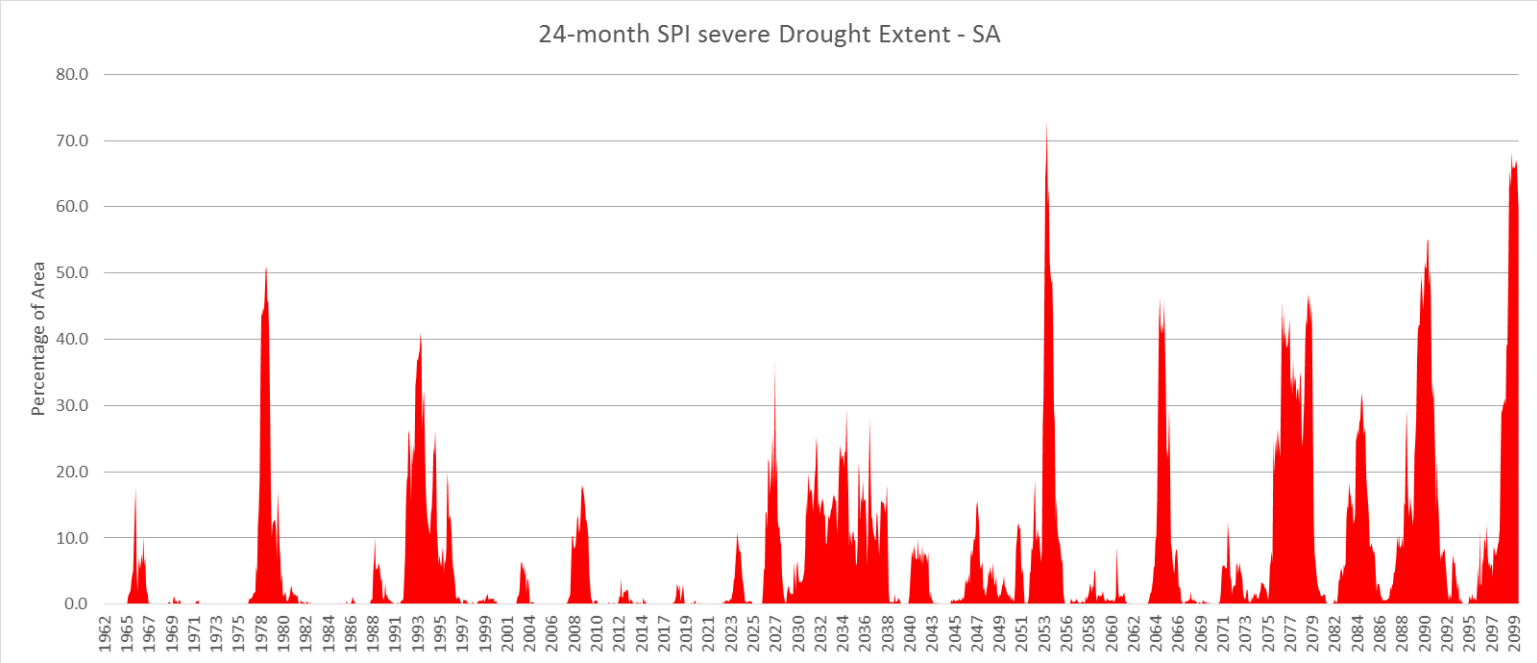

Figure: Area with severe drought, simulated. CCAM-CABLE Downscaling: Input model: ACC. RCP8.5. Period: 1962 – 2099

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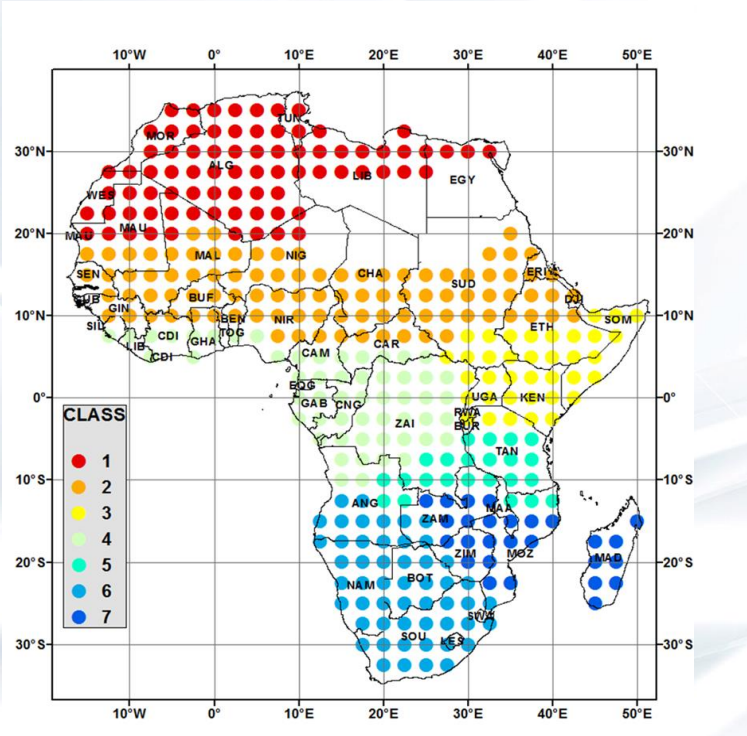
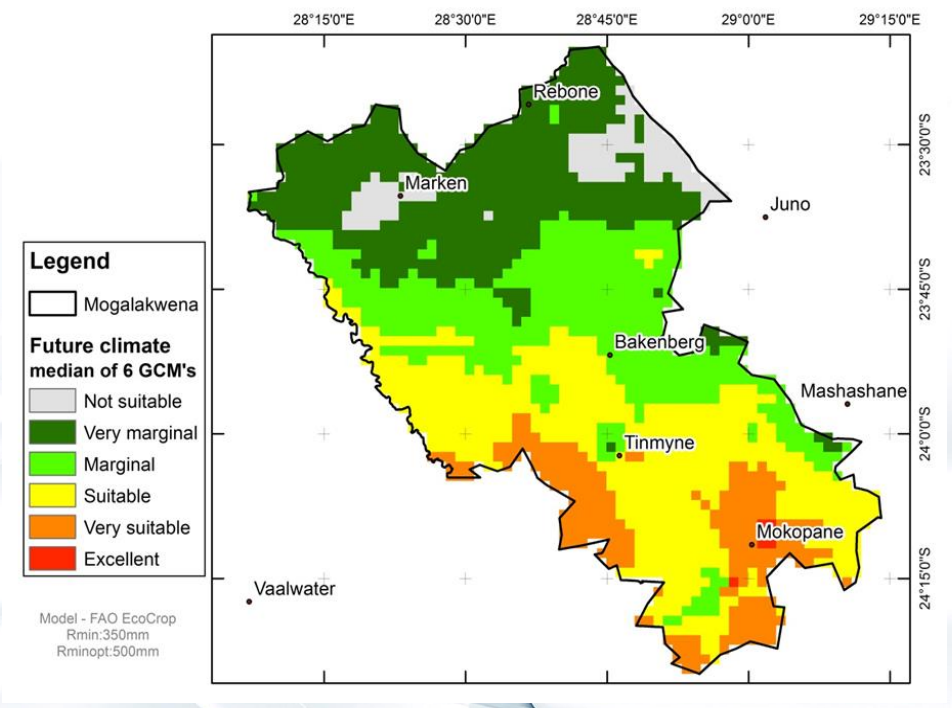
Application of climate simulations

- Crop modelling
- Hydrological modelling
- Urban climate studies
- Potential impacts on Index Insurance





Using climate information to protect human health

- Weather and seasonal forecasting
  - Focus on short-term planning
  - Seasonal time-scales
    - Allows time for resources to be budgeted
  - Weather time-scales
    - Allows for resources and plans to be mobilised

- Climate change (century-long) research
  - Focus on long-term planning

Source: CDC

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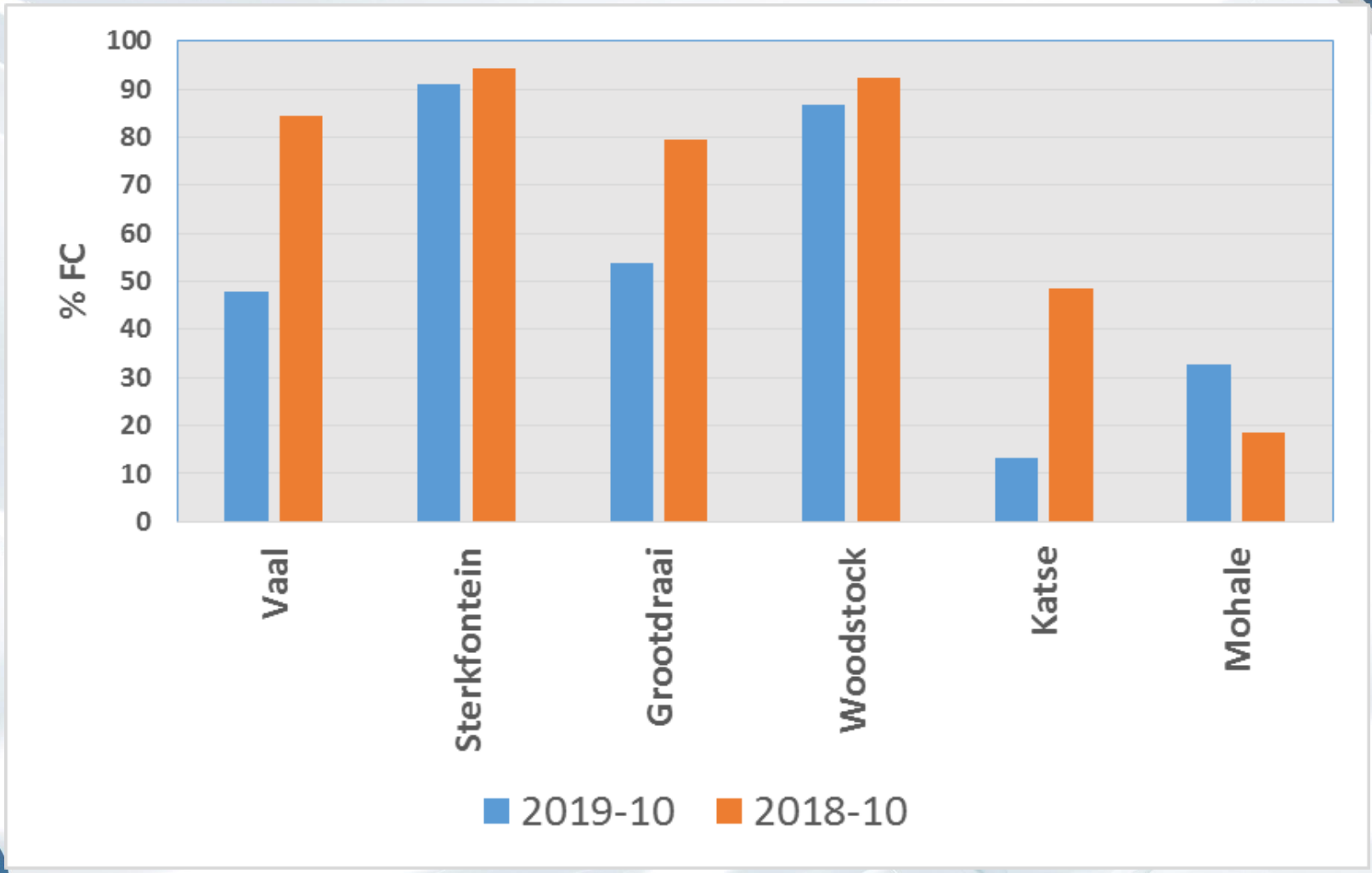
State of the Integrated Vaal River System



Data published by DWS; http://www.dwa.gov.za/Hydrology/Weekly

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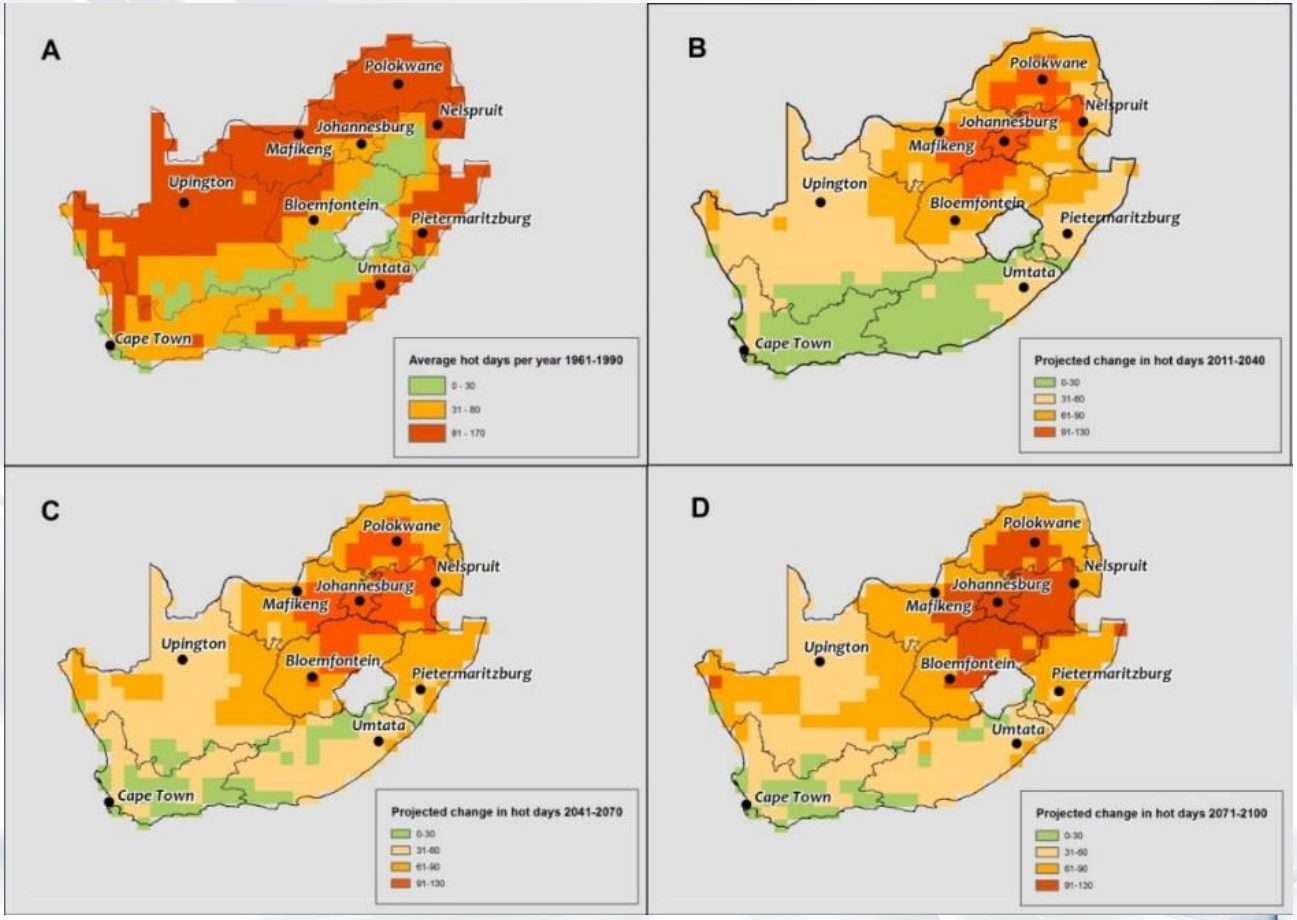
Changes in number of hot days

- Maps highlight present day climate (A), and then change in number of hot days
- Gauteng projected to see **large increases** in hot days



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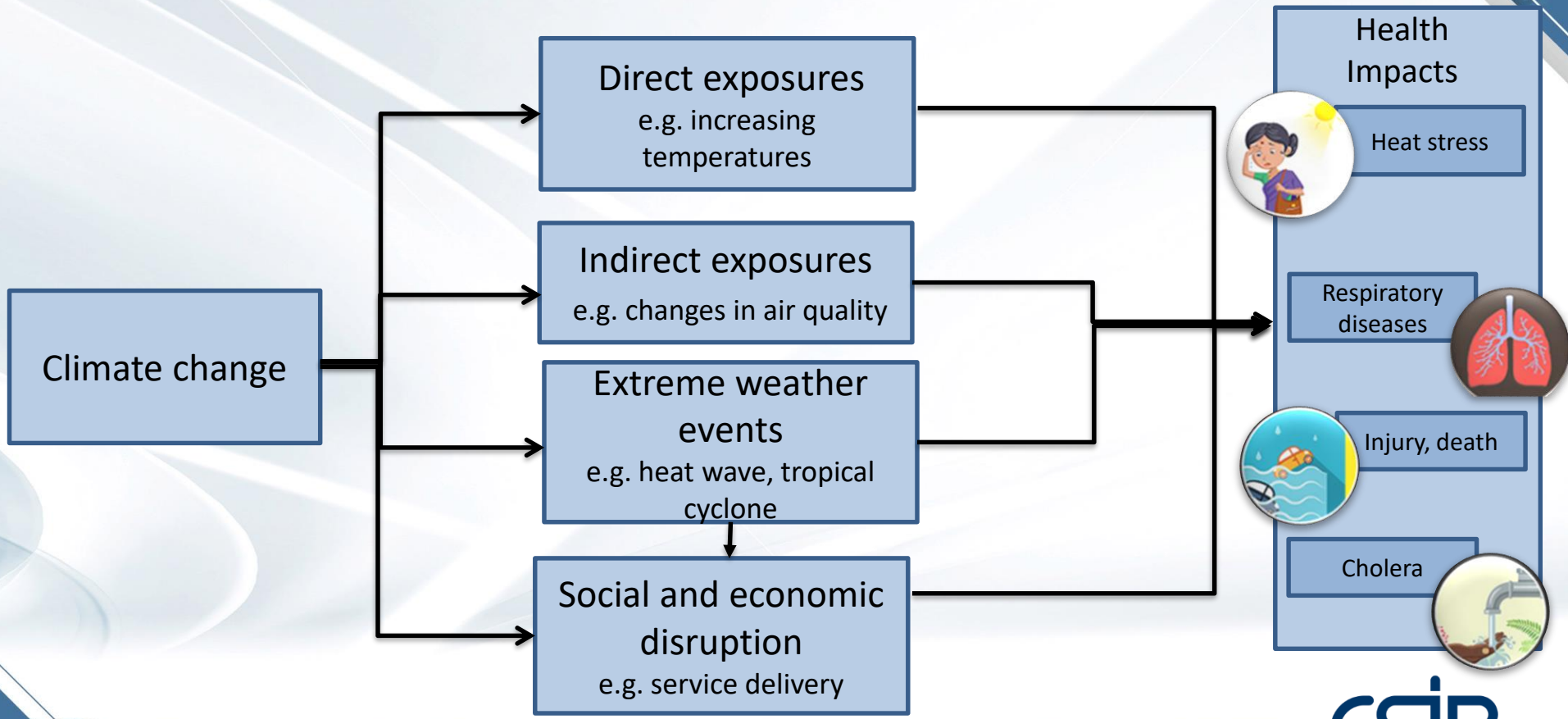
Linkages between climate change and health



Adapted from Garland and Rother, 2017, adapted from Confalonieri et al., 2007; Ahdoot and Pacheco, 2015).

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Factors that influence individual and community level vulnerability to extreme heat events

Adapted from: Health Canada

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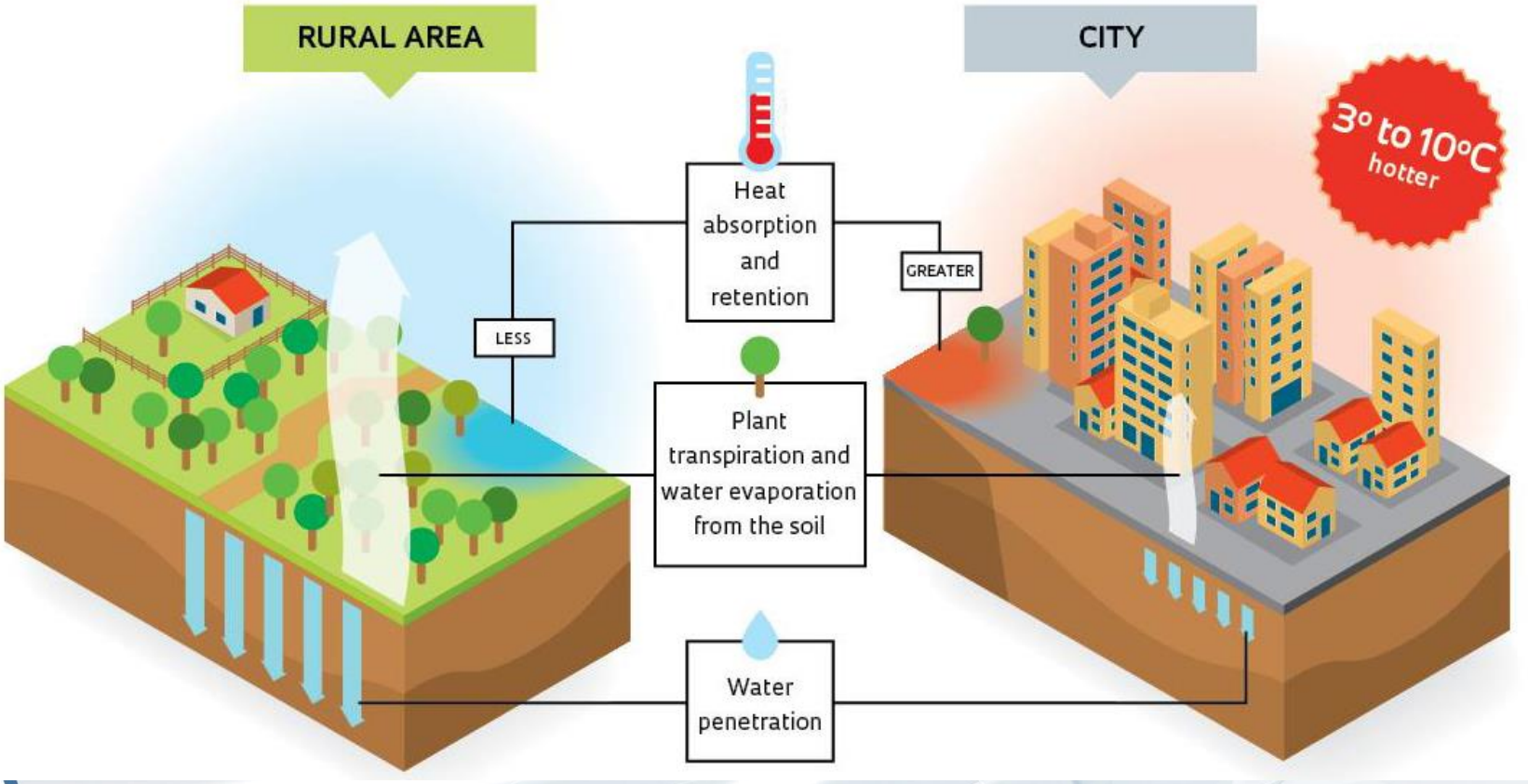
Communities: Cities and heat

- Urbanised areas are usually warmer than surrounding rural area

Urban heat island effect



What can cities do to reduce the extent of the UHI ?

- Various technology and planning options can be used in cities to reduce the extent of the UHI. These include:
  - Green roofs
  - Cool roofs, walls and pavements
  - Green spaces
  - Trees and vegetation
  - Energy efficiency
- Cities need access to research on the UHI and temperature increases

US-EPA, (2012)

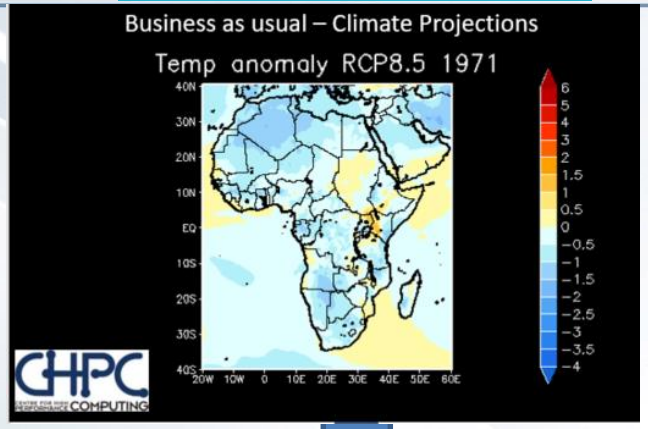
Green residential buildings in Port Elizabeth (GBCSA, 2011)

Steps to develop heat-health action plan (WHO)

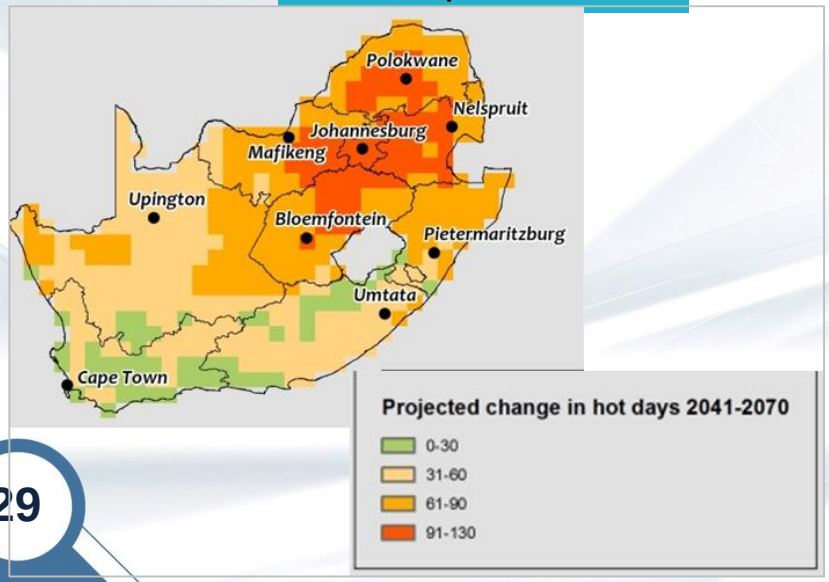
Steps to develop heat-health action plan	Weather and climate-related services
Collaboration between bodies and institutions	Need for weather, atmospheric and climate institutions
Availability of accurate and timeous alert	Need for weather and climate data
Heat-related health information developed in advance	
Avoidance or reduction of heat exposure	
Particular care for vulnerable population	
Provision of health care, social services and infrastructure	
Real-time health surveillance incorporated into planning process	
Monitoring and evaluating components	Forecasts

Heat vulnerability hot spots

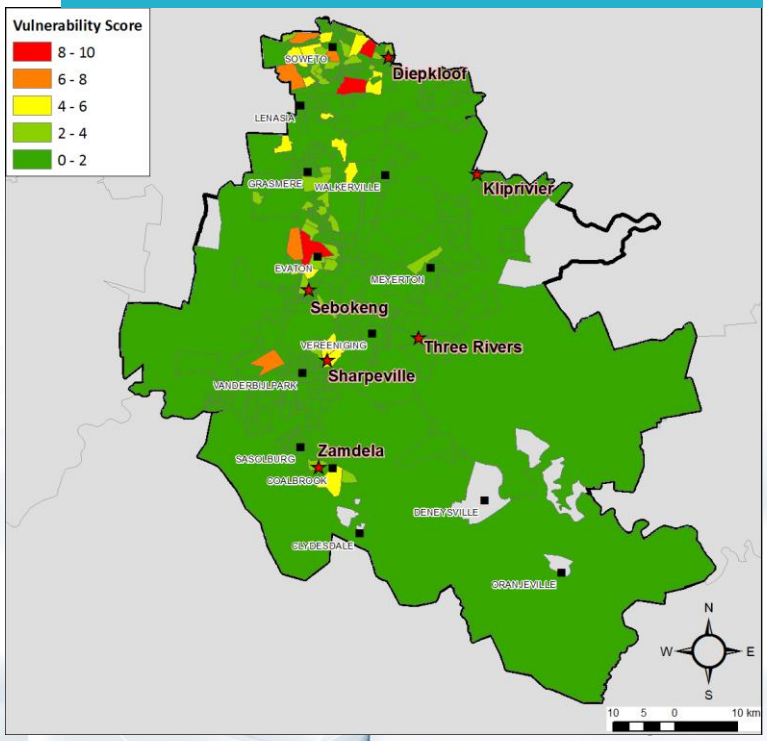
Climate projections



Heat exposure

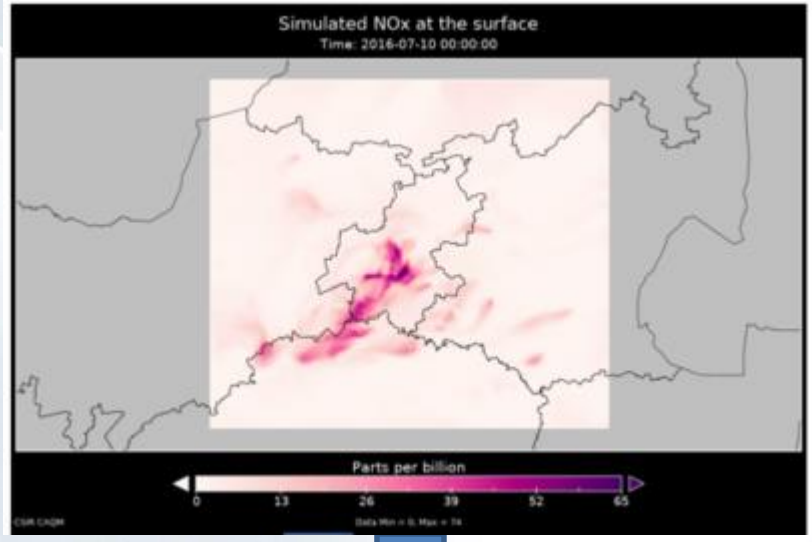


Heat-related social vulnerability

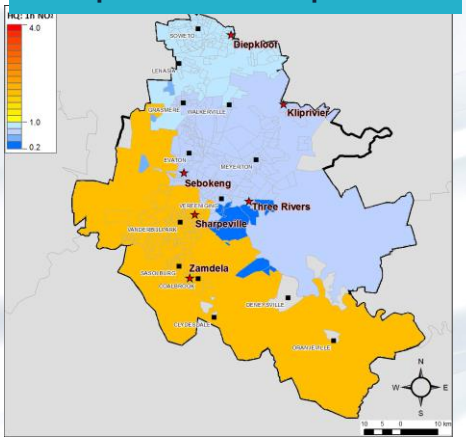


Air pollution exposure hot spots

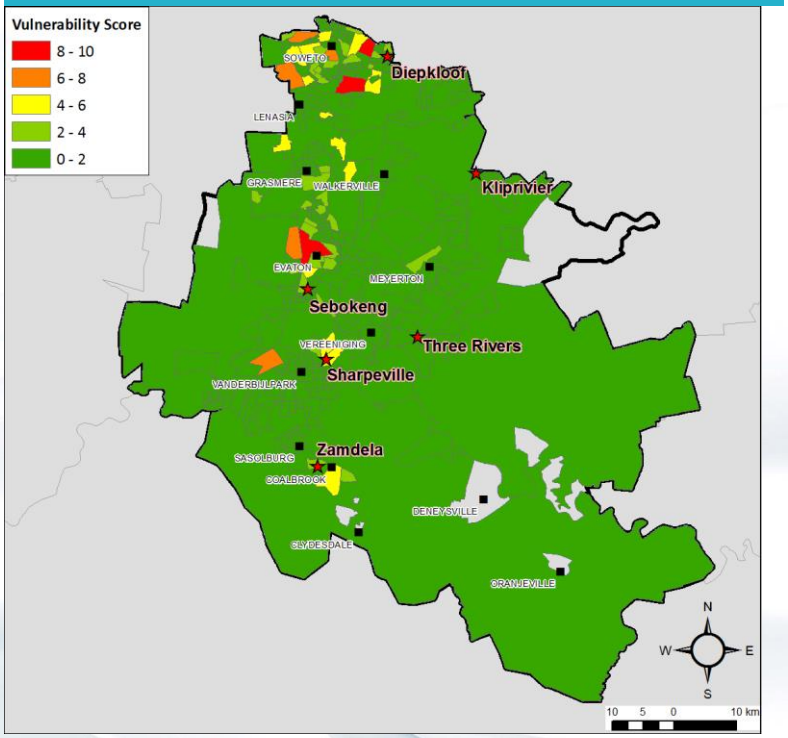
Air quality modelling



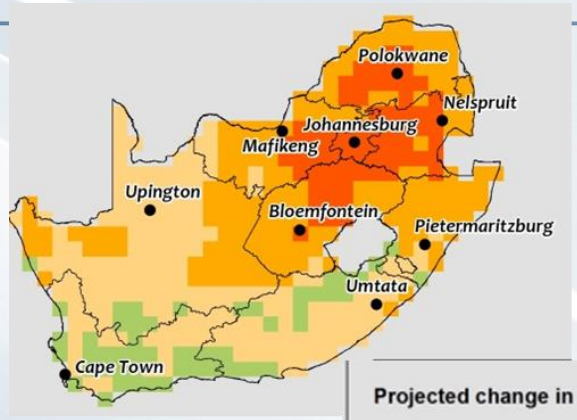
Air pollution exposure



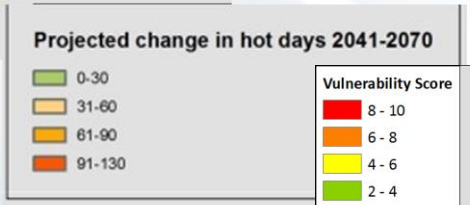
Air pollution-related social vulnerability



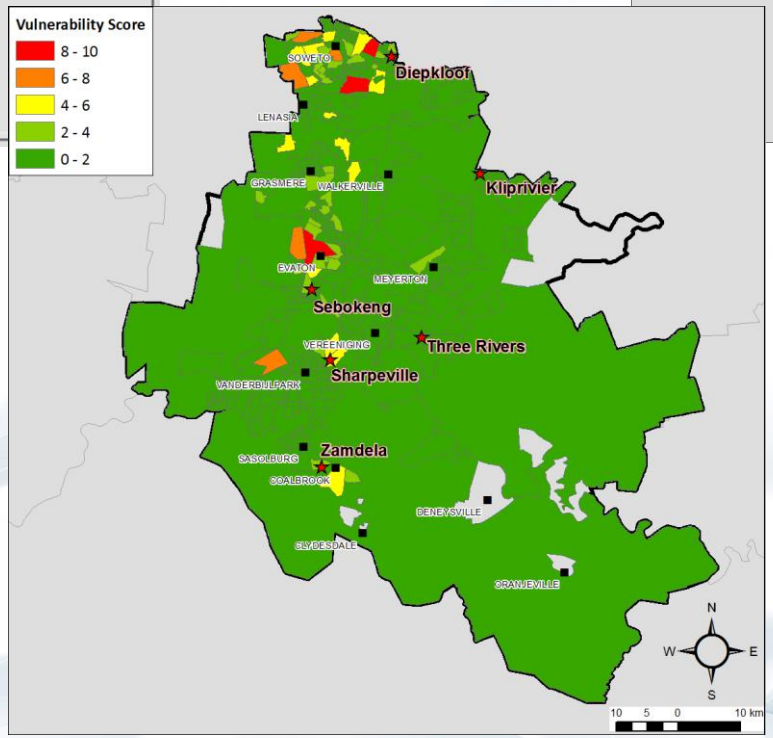
Vulnerability hot spots

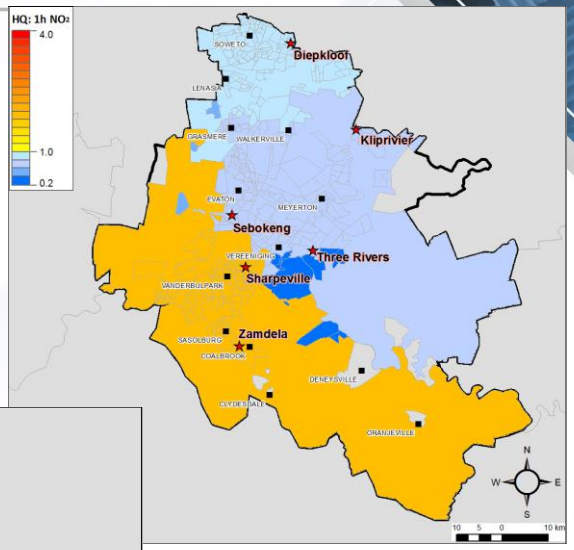


Heat exposure



Vulnerability





Air pollution exposure

Application: Heat Vulnerability Index

The development of an HVI is essential for urban local governments to understand:

- The extent to which heat waves are changing
- The real-life impacts of heat waves on urban populations

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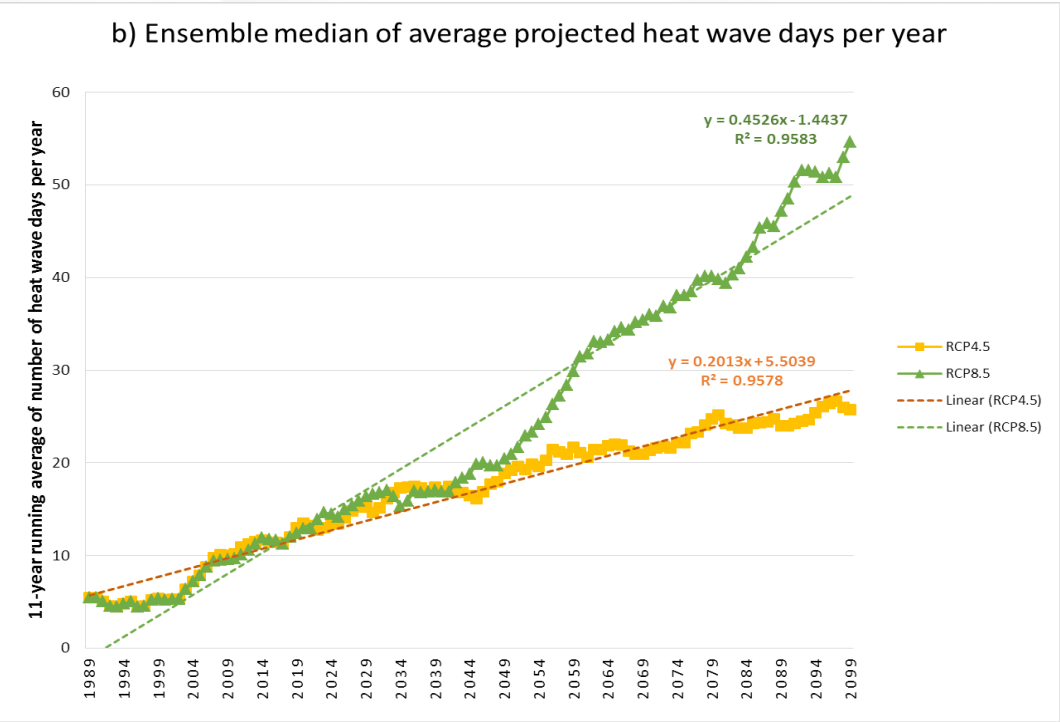
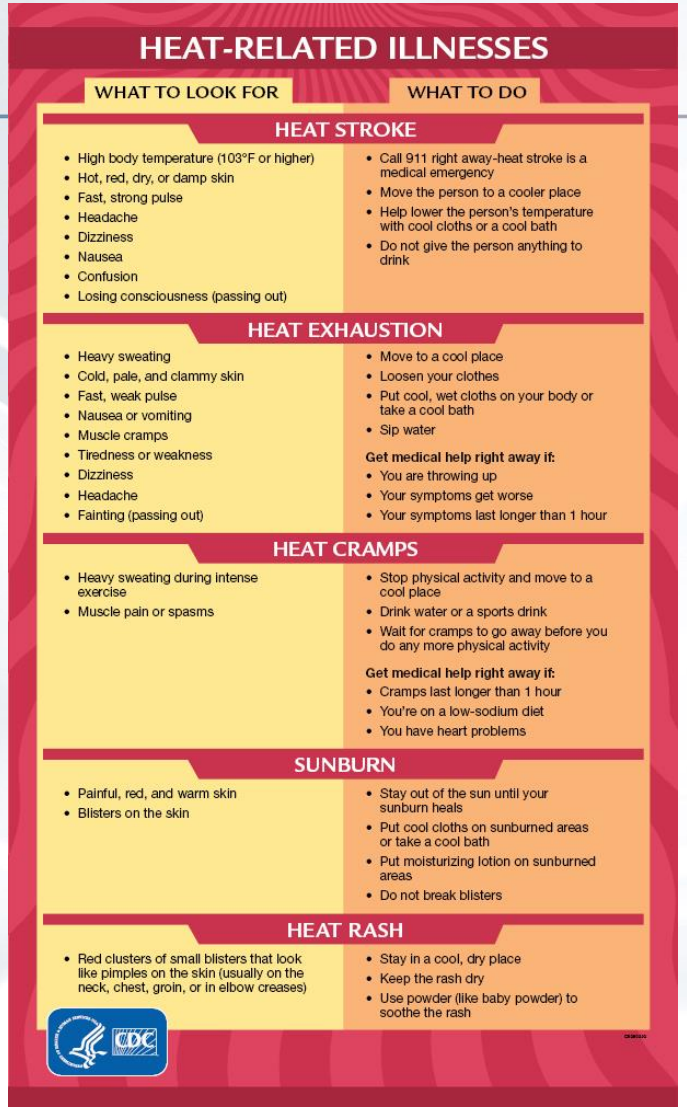
Application: Predict heat wave days

- Heat waves can have large health impact → increasing mortality
- Two different climate change scenarios modelled for CoJ:
  - **Green line**: higher GHG emissions RCP8.5
  - **Orange line**: lower GHG emissions RCP4.5
- Mid-century the two scenarios deviate → **many more heat wave days** projected for **green** line (BAU)

Average number of heat wave days per year in CoJ (two climate futures)



Heat-related illnesses and what to do

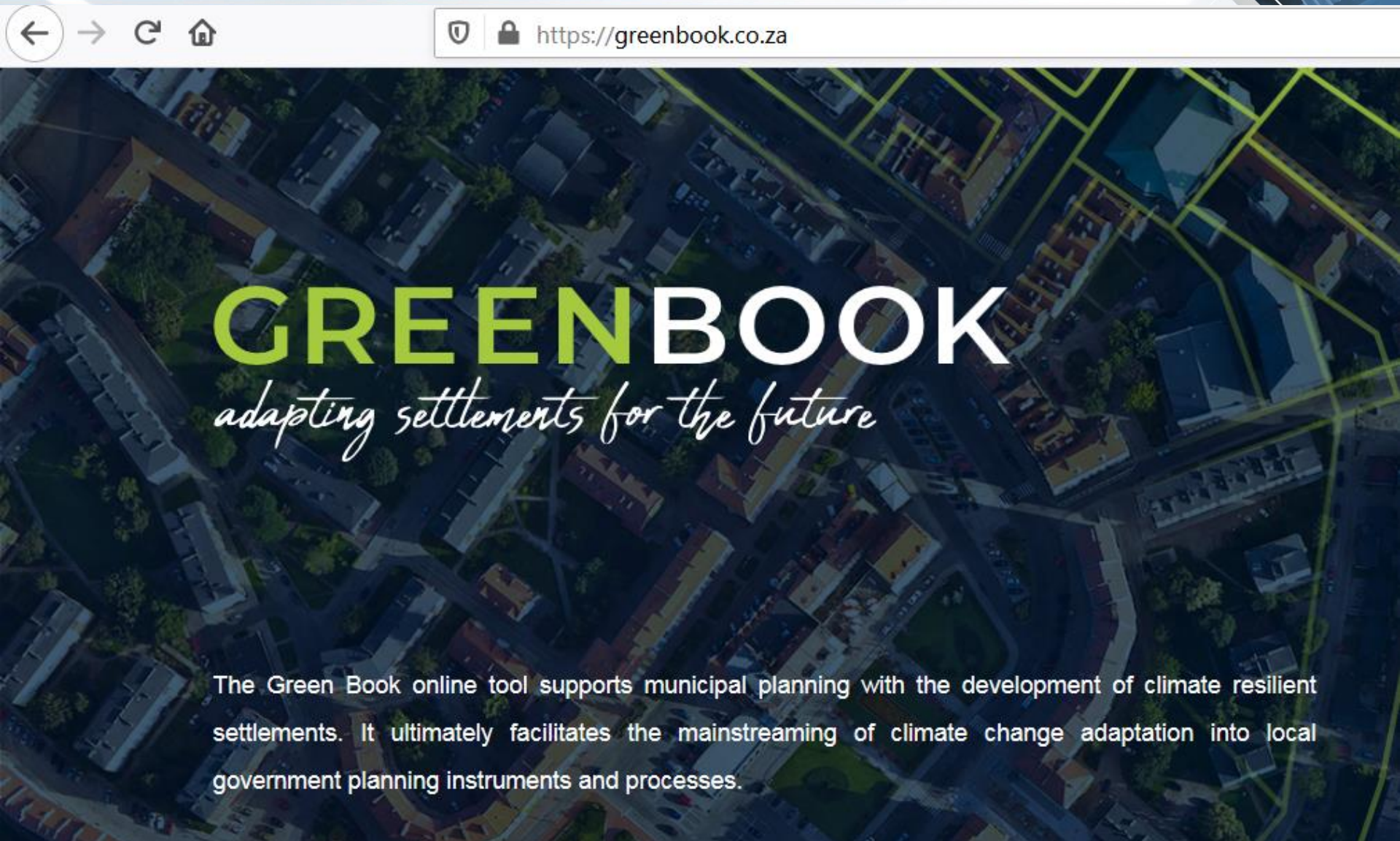


HEAT-RELATED ILLNESSES

WHAT TO LOOK FOR	WHAT TO DO
HEAT STROKE	
• High body temperature (103°F or higher) • Hot, red, dry, or damp skin • Fast, strong pulse • Headache • Dizziness • Nausea • Confusion • Losing consciousness (passing out)	• Call 911 right away-heat stroke is a medical emergency • Move the person to a cooler place • Help lower the person's temperature with cool cloths or a cool bath • Do not give the person anything to drink
HEAT EXHAUSTION	
• Heavy sweating • Cold, pale, and clammy skin • Fast, weak pulse • Nausea or vomiting • Muscle cramps • Tiredness or weakness • Dizziness • Headache • Fainting (passing out)	• Move to a cool place • Loosen your clothes • Put cool, wet cloths on your body or take a cool bath • Sip water **Get medical help right away if:** • You are throwing up • Your symptoms get worse • Your symptoms last longer than 1 hour
HEAT CRAMPS	
• Heavy sweating during intense exercise • Muscle pain or spasms	• Stop physical activity and move to a cool place • Drink water or a sports drink • Wait for cramps to go away before you do any more physical activity **Get medical help right away if:** • Cramps last longer than 1 hour • You're on a low-sodium diet • You have heart problems
SUNBURN	
• Painful, red, and warm skin • Blisters on the skin	• Stay out of the sun until your sunburn heals • Put cool cloths on sunburned areas or take a cool bath • Put moisturizing lotion on sunburned areas • Do not break blisters
HEAT RASH	
• Red clusters of small blisters that look like pimples on the skin (usually on the neck, chest, groin, or in elbow creases)	• Stay in a cool, dry place • Keep the rash dry • Use powder (like baby powder) to soothe the rash

Source: https://www.cdc.gov/disasters/extremeheat/warning.html

Application of climate simulations



Summary

- Climate change is expected to have large impacts on health, but little is known what impacts have already happened and what might happen in future→ **area where local observations and information are needed**
- Warming has already been happening
- Many current health issues are climate-sensitive and thus may be impacted by climate change → adding an additional stressor to health field (public and occupational)
- Important to include assessment of non-climate factors into understanding what might be health impact
- Projections of hot days for South Africa show large increases. Moving forward we need to quantify potential risk – need local relationships of temperature and mortality. Also, on-going work on heat wave projections.
- Current critical needs are in local studies of impact of climate on health (past, present and future) → **DATA**

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