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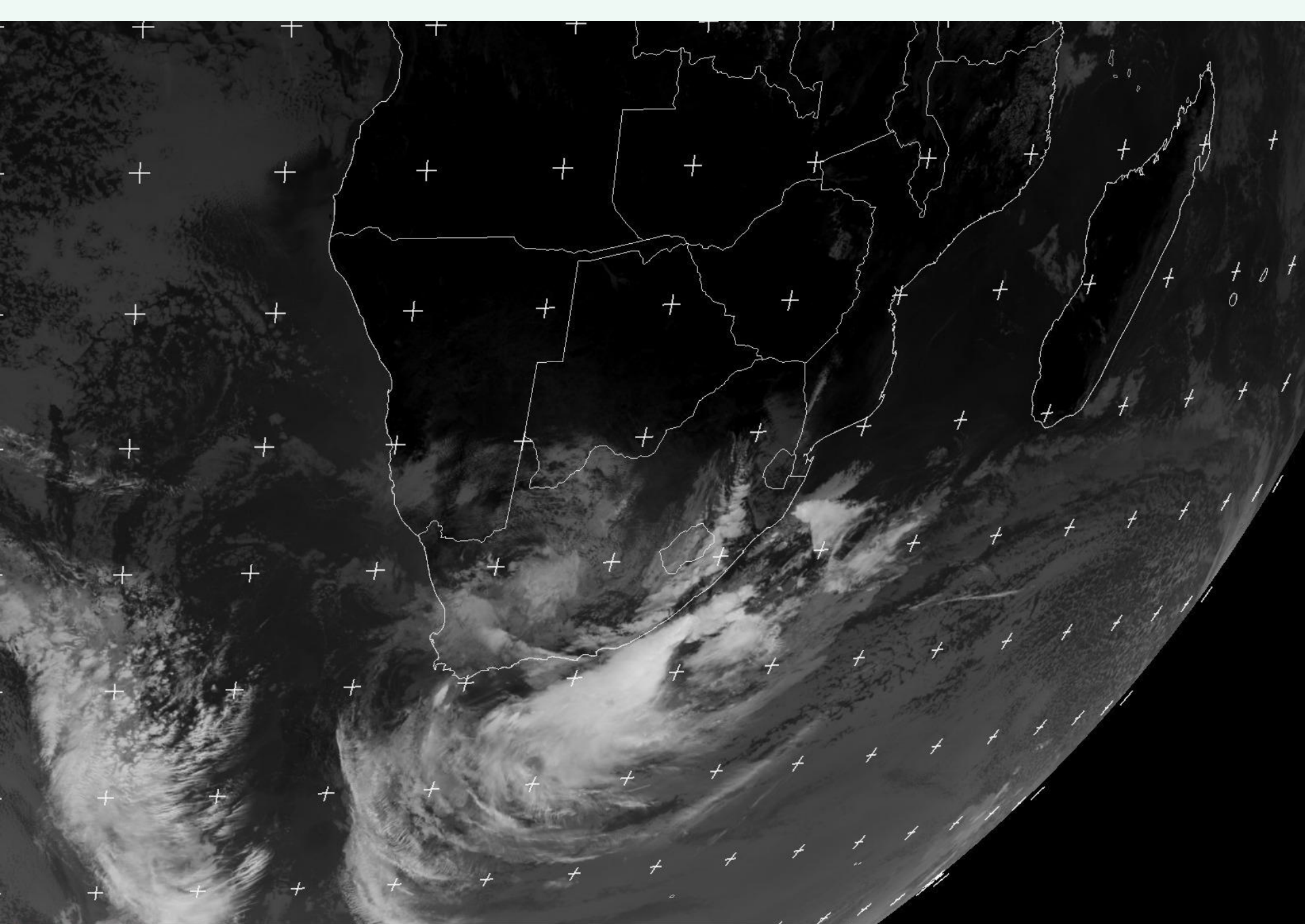
Projections of future climate change and climate change tipping points in southern Africa

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Global Change Institute

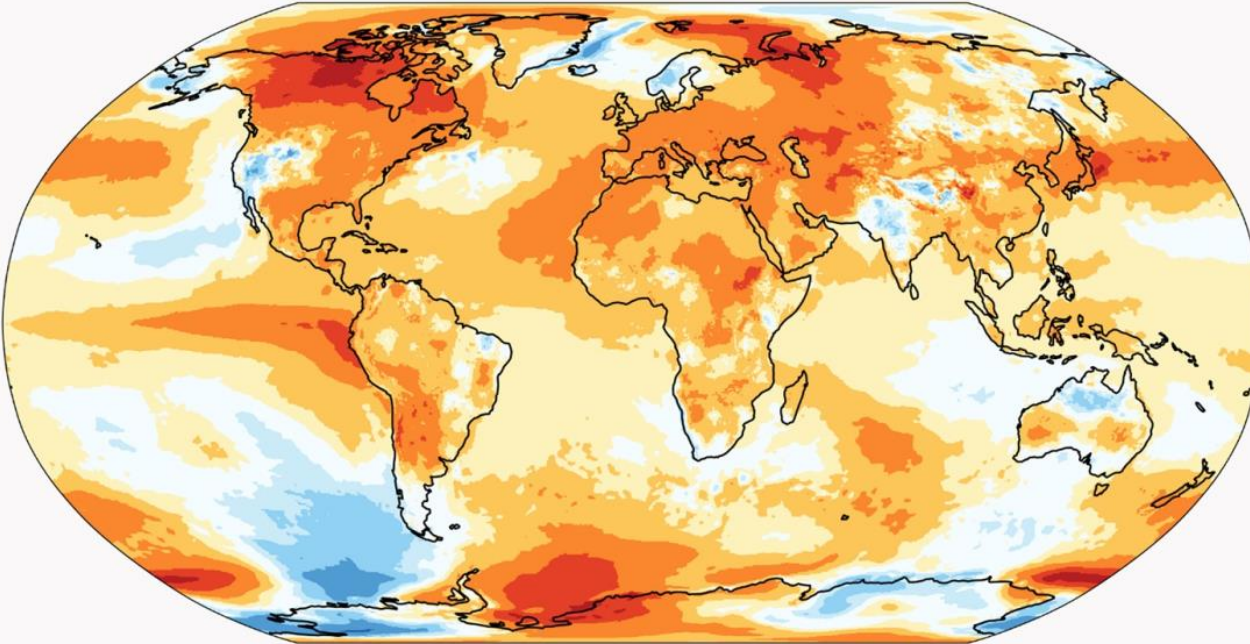
University of the Witwatersrand

With contributions from Jessica Steinkopf, Wits GCI

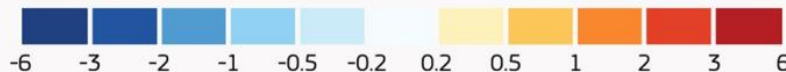


SURFACE AIR TEMPERATURE ANOMALY • 2023

Reference period: 1991–2020 • Data: ERA5 • Credit: C3S/ECMWF



Temperature anomaly (°C)



PROGRAMME OF
THE EUROPEAN UNION



IMPLEMENTED BY



2023 is the warmest calendar year on record, 1.48°C above the pre-industrial (1850-1900) average. The period Feb 2023 to Jan 2024 is the first exceeded the 1.5°C threshold.

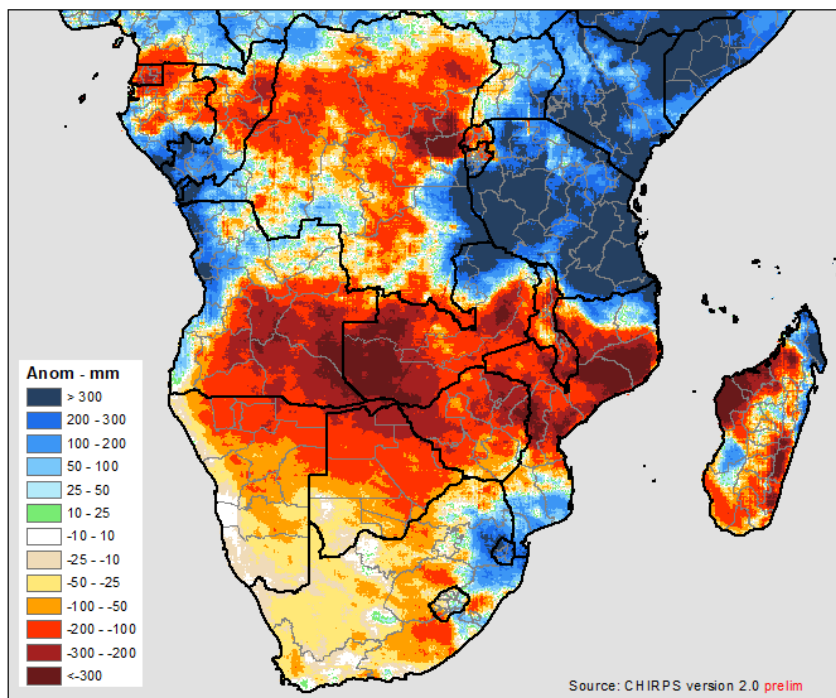
- The Paris Agreement on Climate Change aims to keep global warming to 'well below 2°C , preferably below 1.5°C '.
- Above 1.5°C of global warming, the world will be more dangerous in terms of extreme weather events.
- Aspects of climate change may become irreversible.

Drought in southern Africa during the summer of 2023/24

Seasonal Rainfall Accumulation Anomaly by pentad

2023-2024 season Oct - May

(Oct pentad 1 2023 thru May pentad 1 2024) - Average (1981-2010)



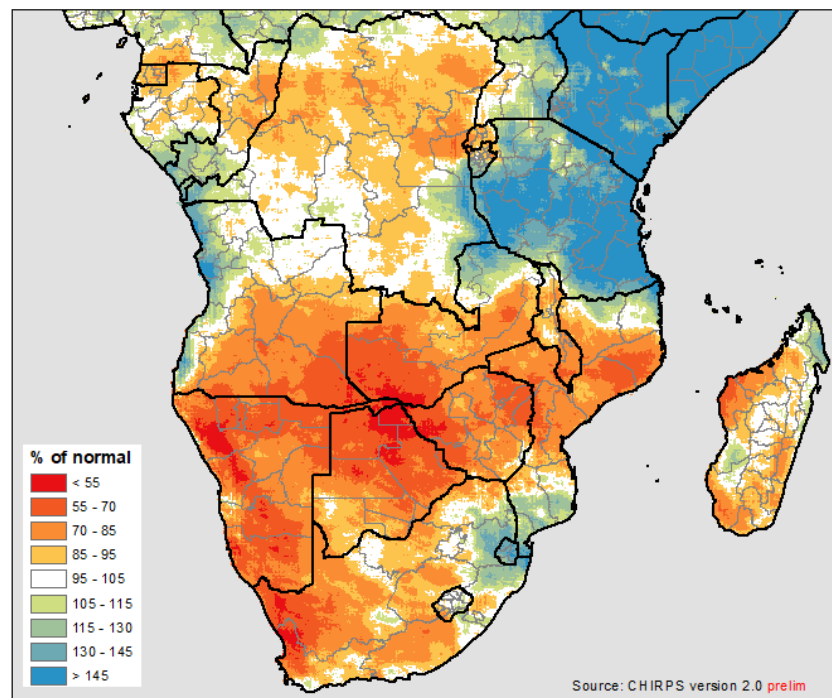
Map produced by USGS/EROS



Seasonal Rainfall Accumulation Percent of Normal by pentad

2023-2024 season Oct - May

(Oct pentad 1 2023 thru May pentad 1 2024) / Avg (1981-2010) * 100



Map produced by USGS/EROS



El Niño/La Niña: predicted transition in 2024

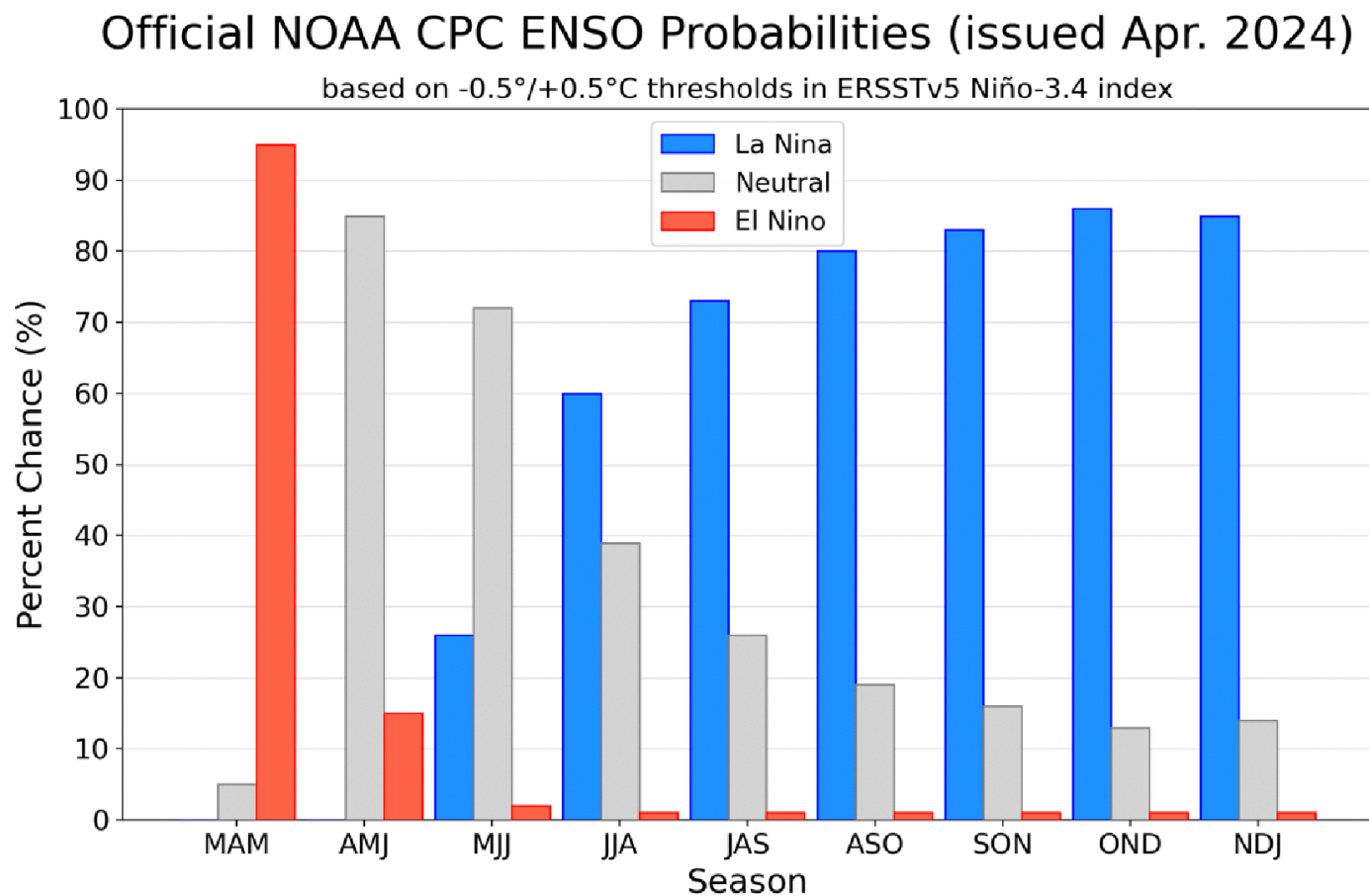
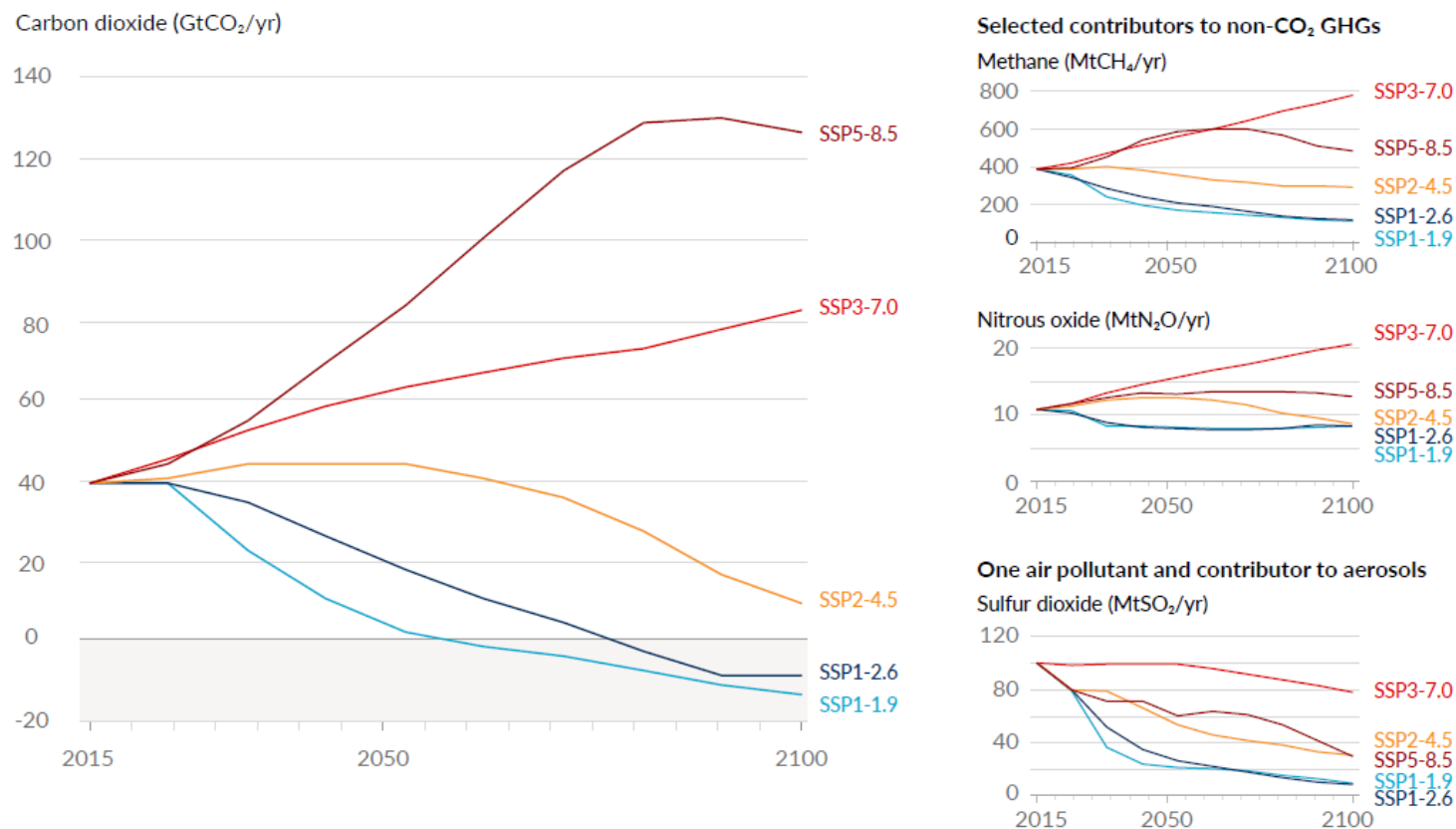


Figure 7. Official ENSO probabilities for the Niño 3.4 sea surface temperature index (5°N - 5°S , 120°W - 170°W). Figure updated 11 April 2024.



Future emissions cause future additional warming, with total warming dominated by past and future CO₂ emissions

a) Future annual emissions of CO₂ (left) and of a subset of key non-CO₂ drivers (right), across five illustrative scenarios

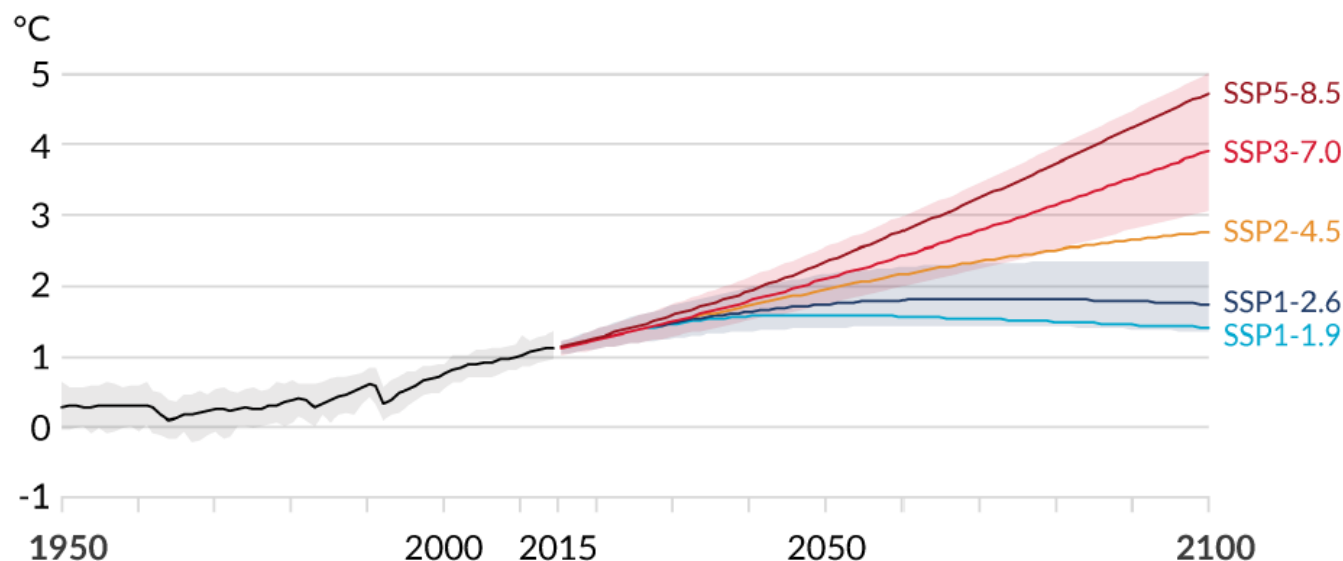




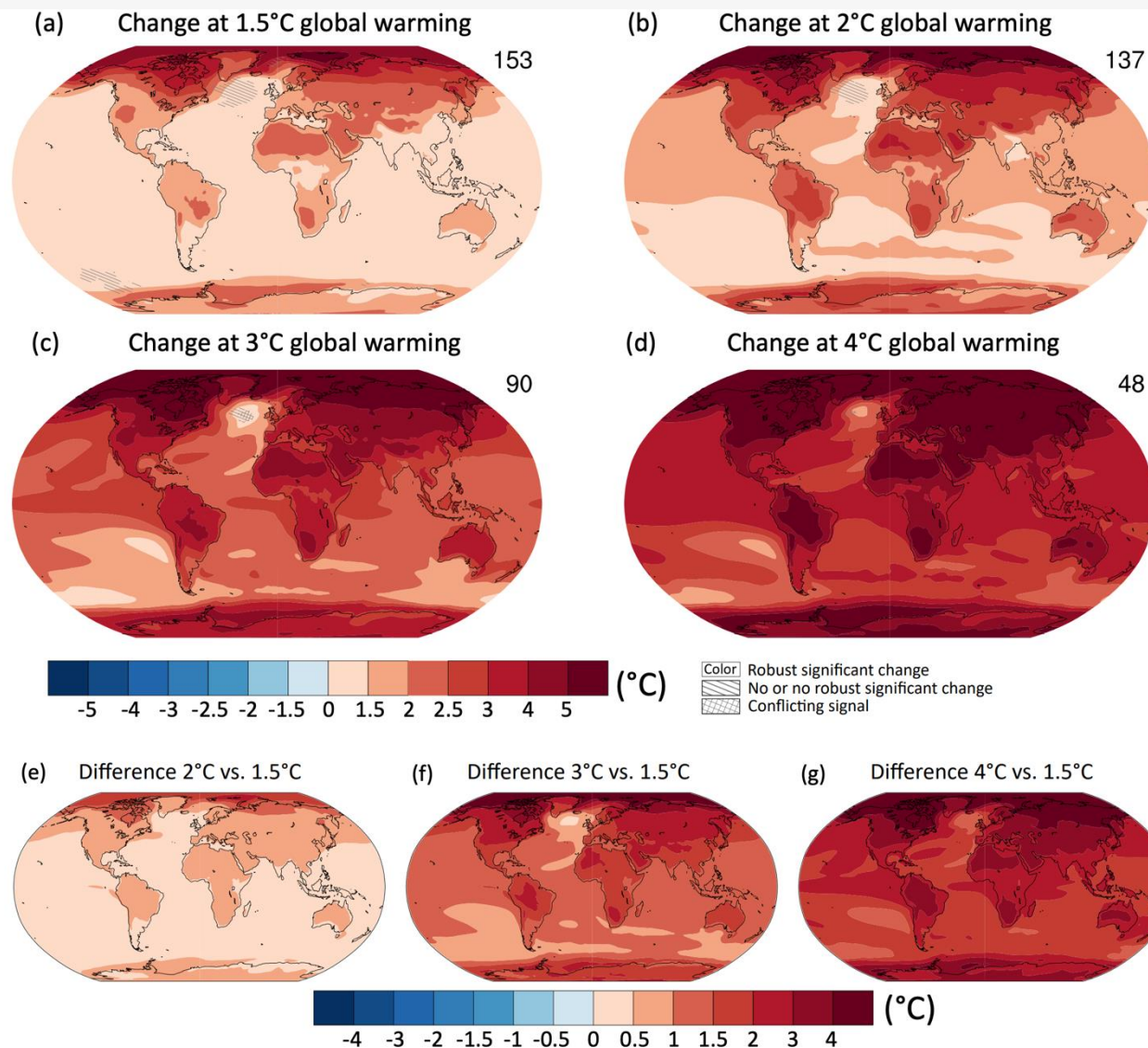
Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8

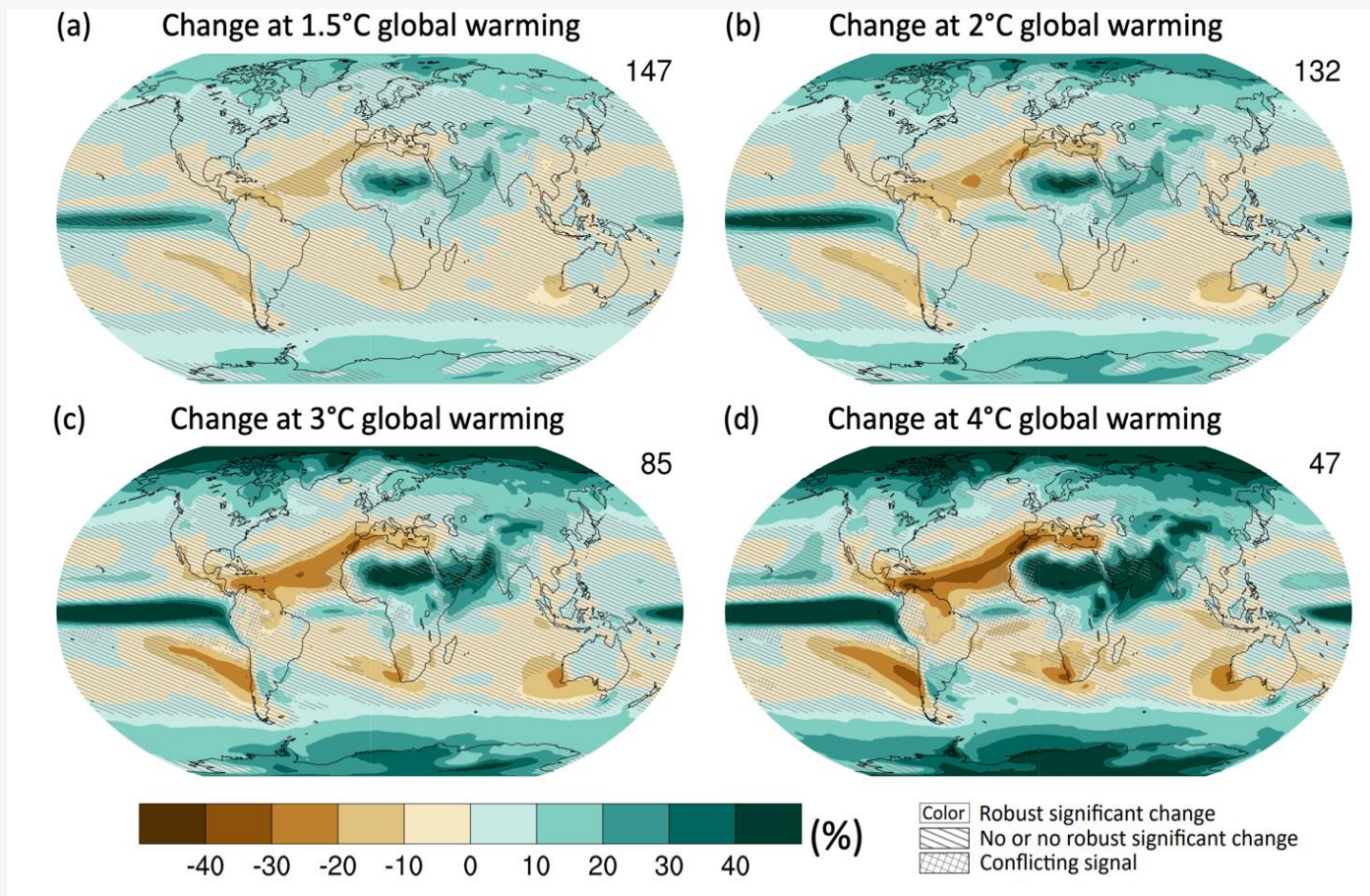
a) Global surface temperature change relative to 1850-1900



Under the five illustrative scenarios, in the near term (2021-2040), the 1.5° C global warming level is *very likely* to be exceeded under the very high GHG emissions scenario (SSP5-8.5), *likely* to be exceeded under the intermediate and high GHG emissions scenarios (SSP2-4.5 and SSP3-7.0), *more likely than not* to be exceeded under the low GHG emissions scenario (SSP1-2.6) and *more likely than not* to be reached under the very low GHG emissions scenario (SSP1-1.9).

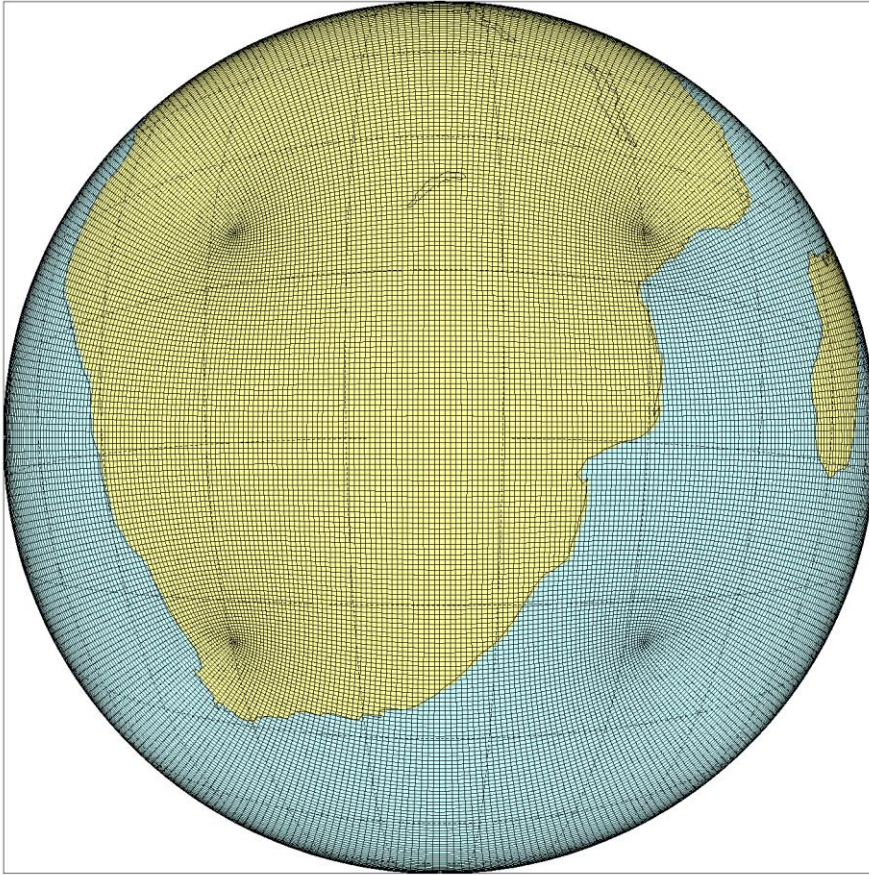


Projected spatial patterns of change in annual average near-surface temperature (°C) at different levels of global warming (Figure 4.31, Chapter 4, AR6).



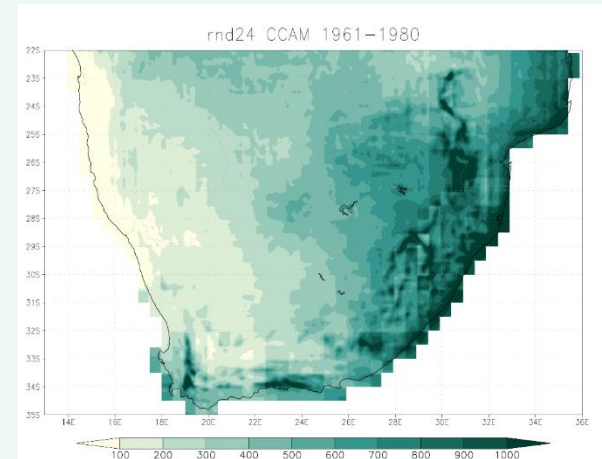
Projected spatial patterns of change in annual average precipitation (expressed as a percentage change) at different levels of global warming (Figure 4.32. Chapter 4, AR6 WGI report.

Regional climate models are used to downscale the projections of global climate models to finer spatial details.



Southern African domain for regional climate modelling at Wits

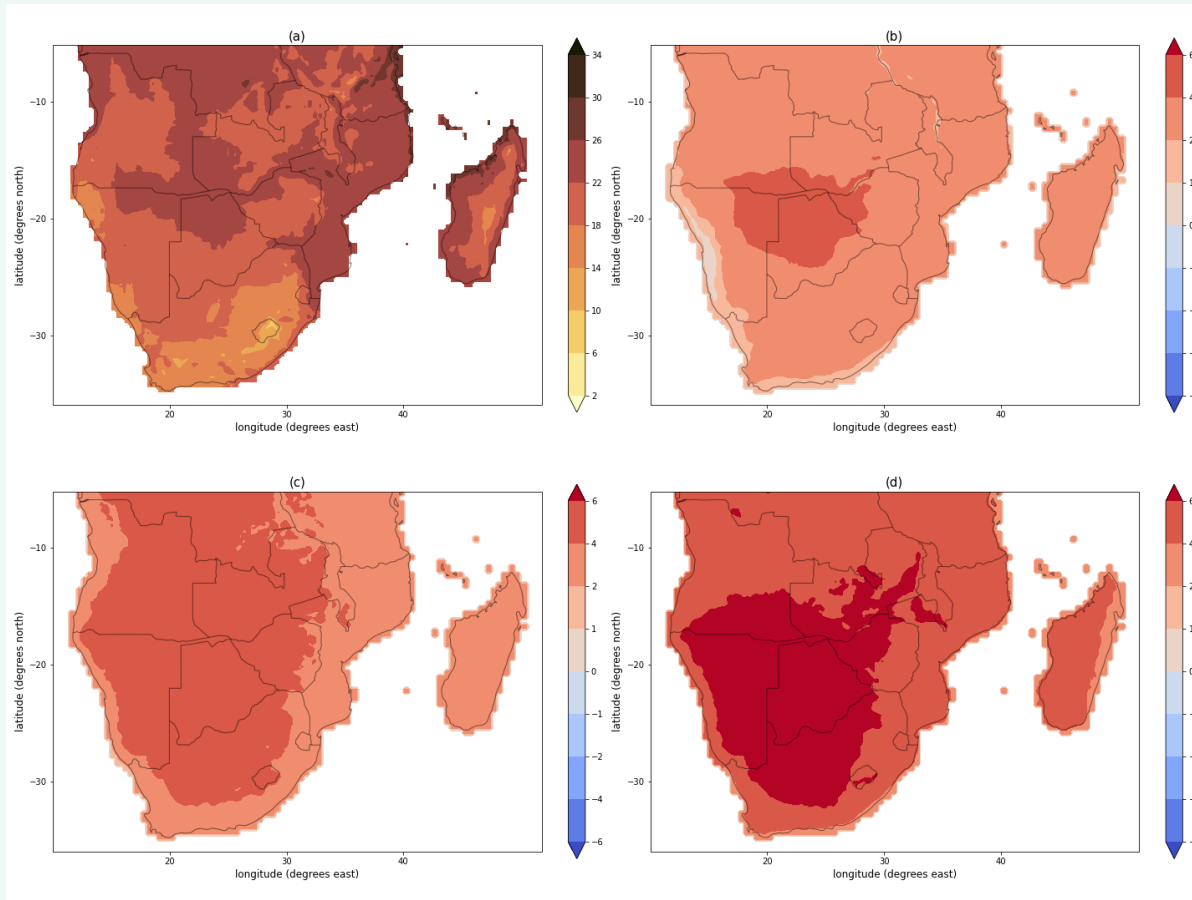
Bias-corrected simulations available to support climate change impact modelling in southern Africa and Africa.



SA-TIED

Southern Africa – Towards Inclusive Economic Development

Projected changes in temperature

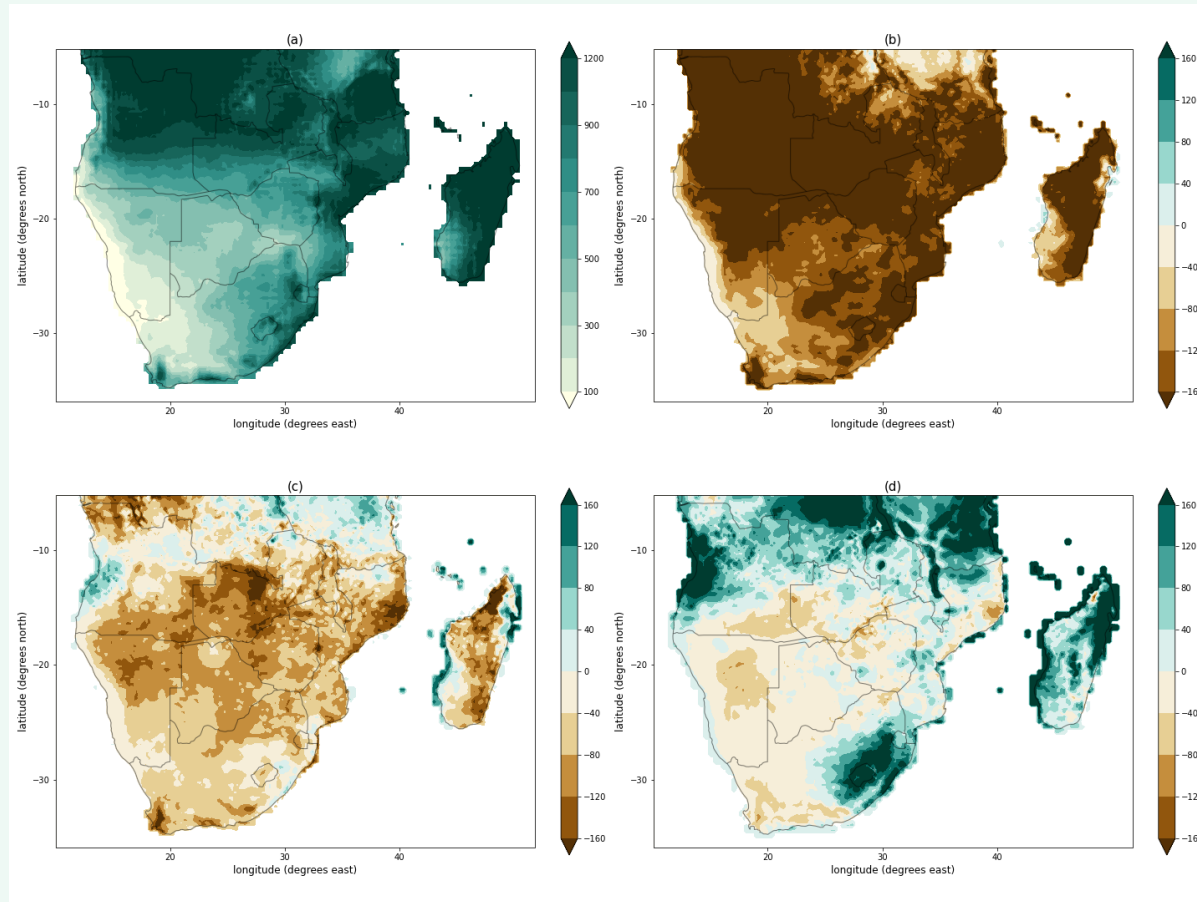


Southern Africa is projected to become systematically drier and drastically warmer.

Drastic increases in average temperature are projected under low mitigation futures.

Figure shows the projected changes in the annual average temperature ($^{\circ}$ C) for the ensemble of 9 CORDEX-core RCMs for 2080-2099 relative to 1981-2000.

Projected changes in rainfall

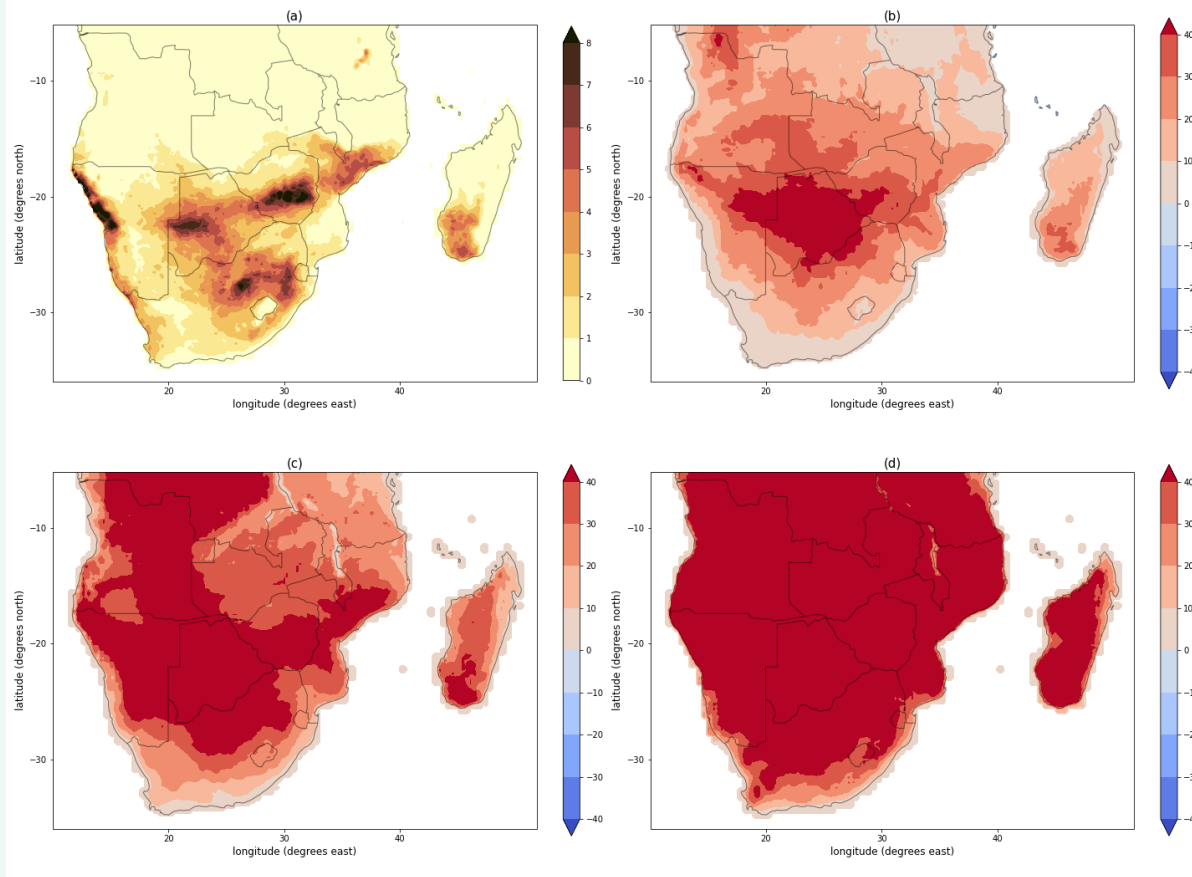


A decrease in annual rainfall totals can already be detected over South Africa's winter rainfall region as well as over the summer rainfall region of eastern South Africa (observational trend over the last five decades; IPCC AR6 WGI report). Most climate models project general decreases in annual rainfall across the southern African region.

Over the eastern escarpment area of South Africa rainfall futures are uncertain, with some models projecting increases in annual rainfall.

Figure shows the projected changes in annual rainfall totals (mm) across the ensemble of 9 CORDEX-core RCMs for 2080-2099 relative to 1981-2000.

Projected changes in heat-wave days

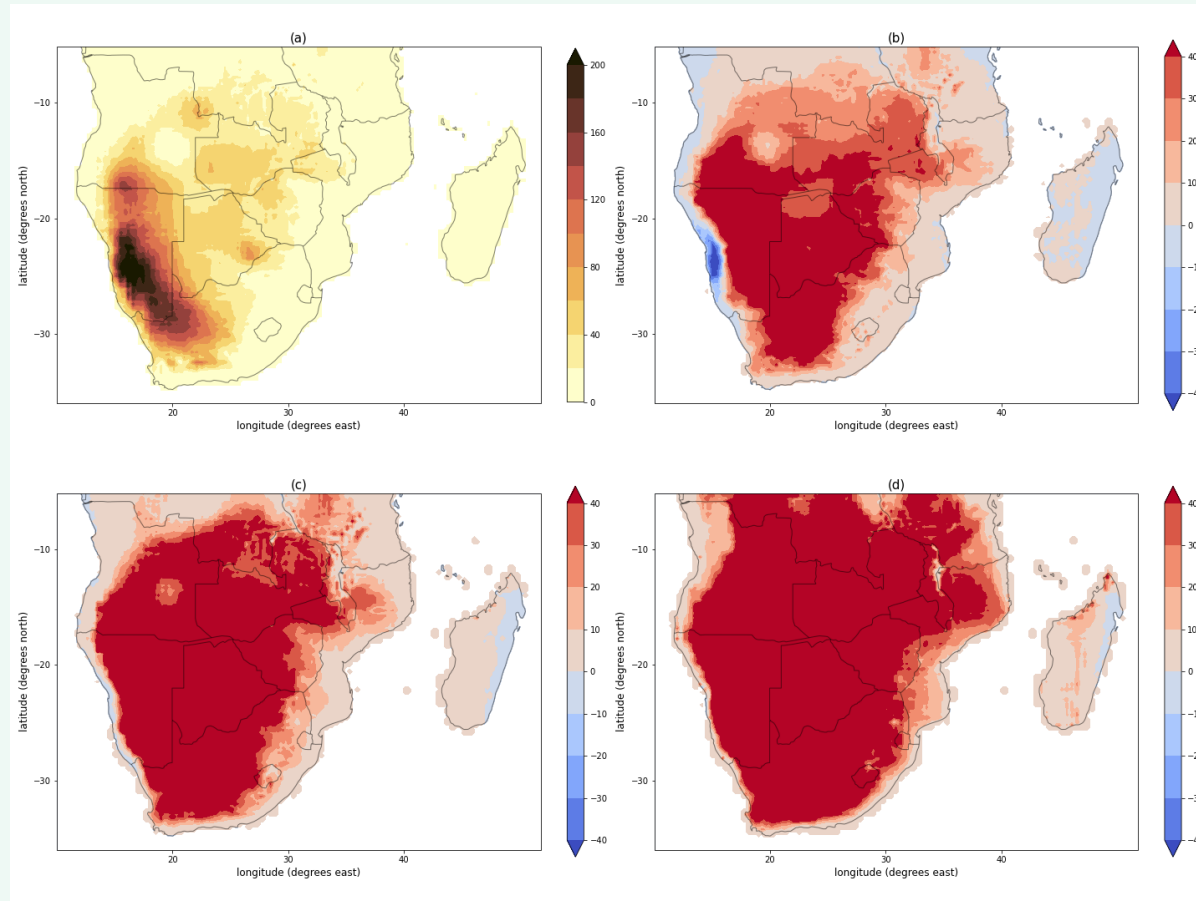


Drastic increases in heat-wave days (shown as number of events per year per location) occur in association with an increase in the number of high fire-danger days.

The projected increase in heat-wave days co-occur with projections of a generally drier climate. Options of adaptation are limited.

Figure shows the projected changes in the annual number of heat-wave days across the ensemble of 9 CORDEX-core RCMs for 2080-2099 relative to 1981-2000.

Projected changes in meteorological high fire-danger days



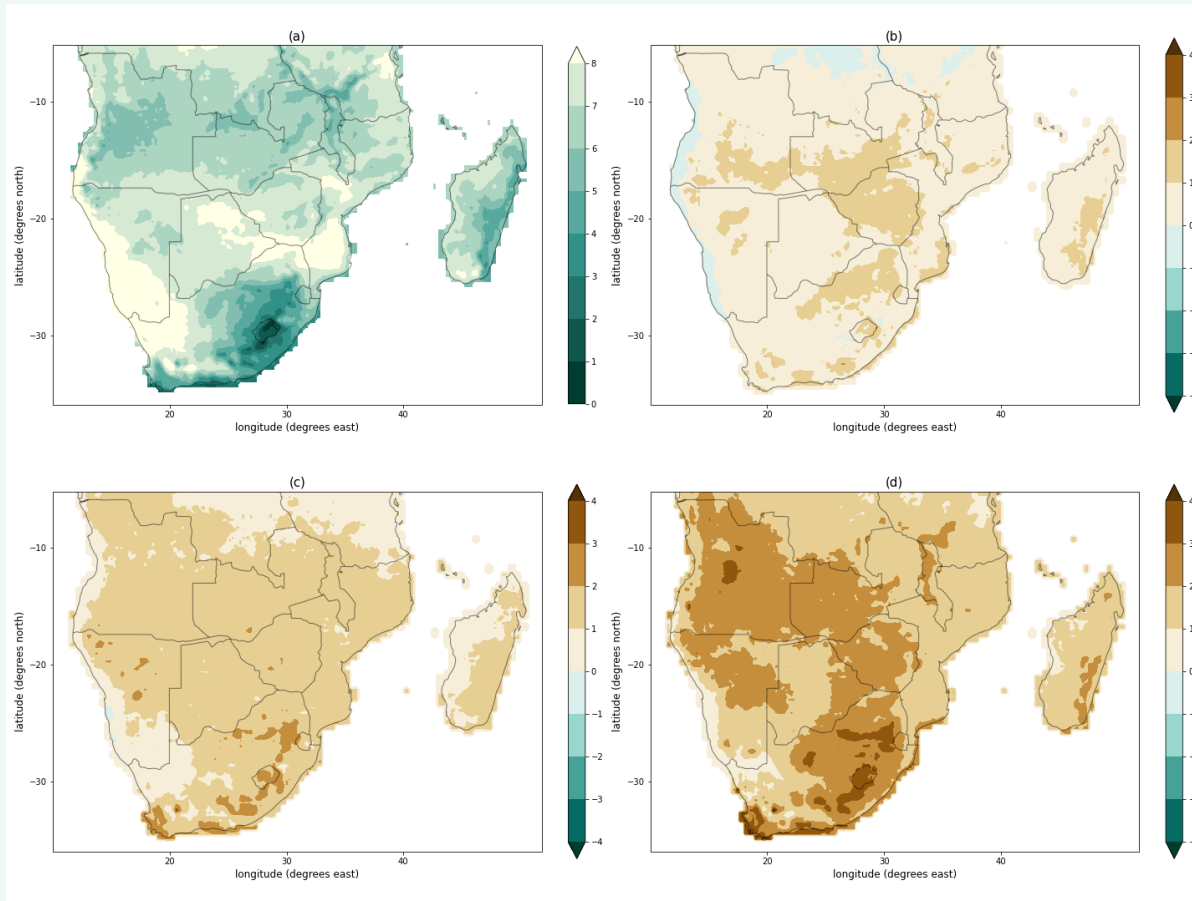
Drastic increases in the number of high fire-danger days (shown as number of events per year per location) occur in association with an increase in the number of heat-wave days.

The projected increase in high fire-danger days co-occur with projections of a generally drier climate.

Options of adaptation are limited.

Figure shows the projected changes in the annual number of high fire-danger days across the ensemble of 9 CORDEX-core RCMs for 2081-2100 relative to 1981-2000.

Projected changes in soil-moisture



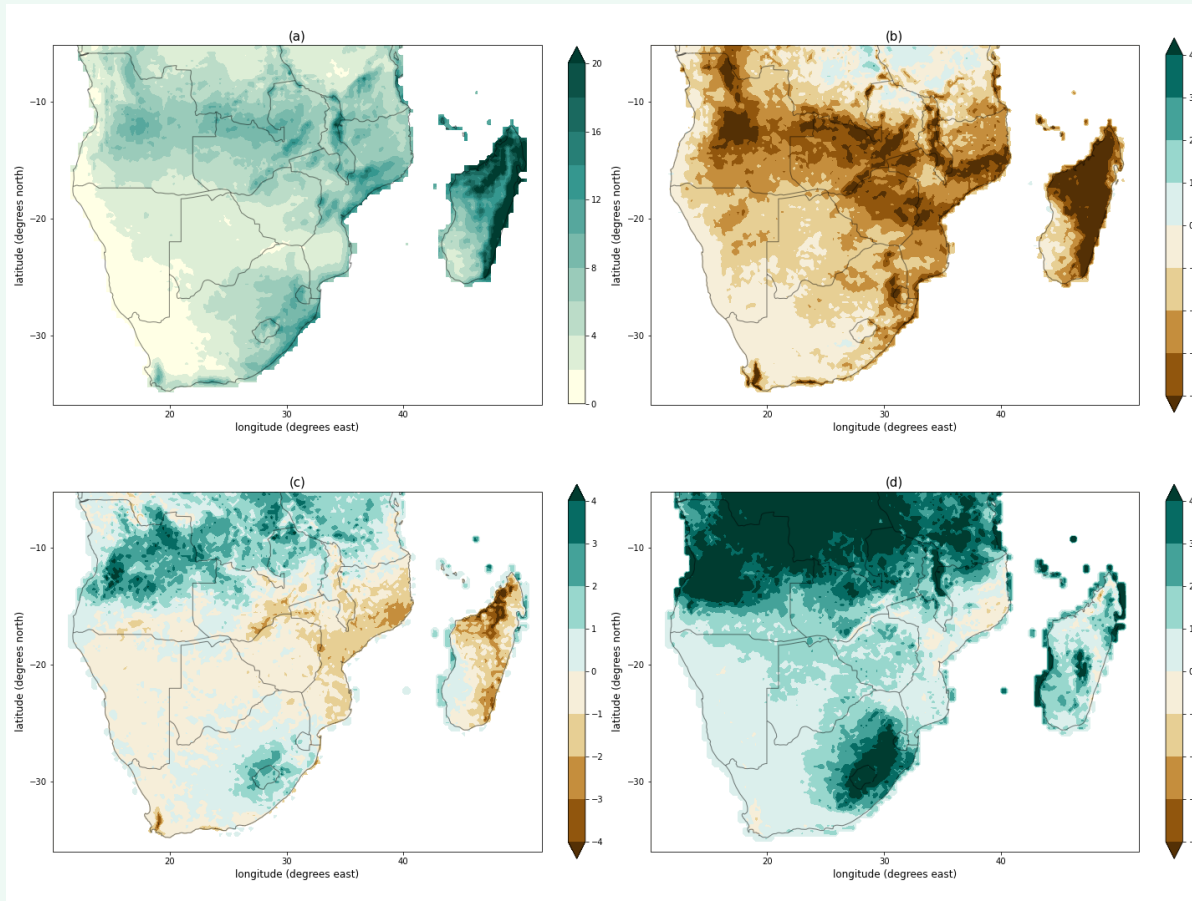
Southern Africa is projected to become generally drier under low-mitigation climate change futures (IPCC AR4, AR5, AR6).

Corresponding decreases in soil-moisture are projected.

The projections of decreasing soil-moisture are robust, and hold even in regions where increases in precipitation totals are projected. This is due to higher evaporation rates in the regionally warmer world.

Figure shows the projected changes in the annual Keetch-Byram drought index across the ensemble of 9 CORDEX-core RCMs for 2081-2100 relative to 1981-2000.

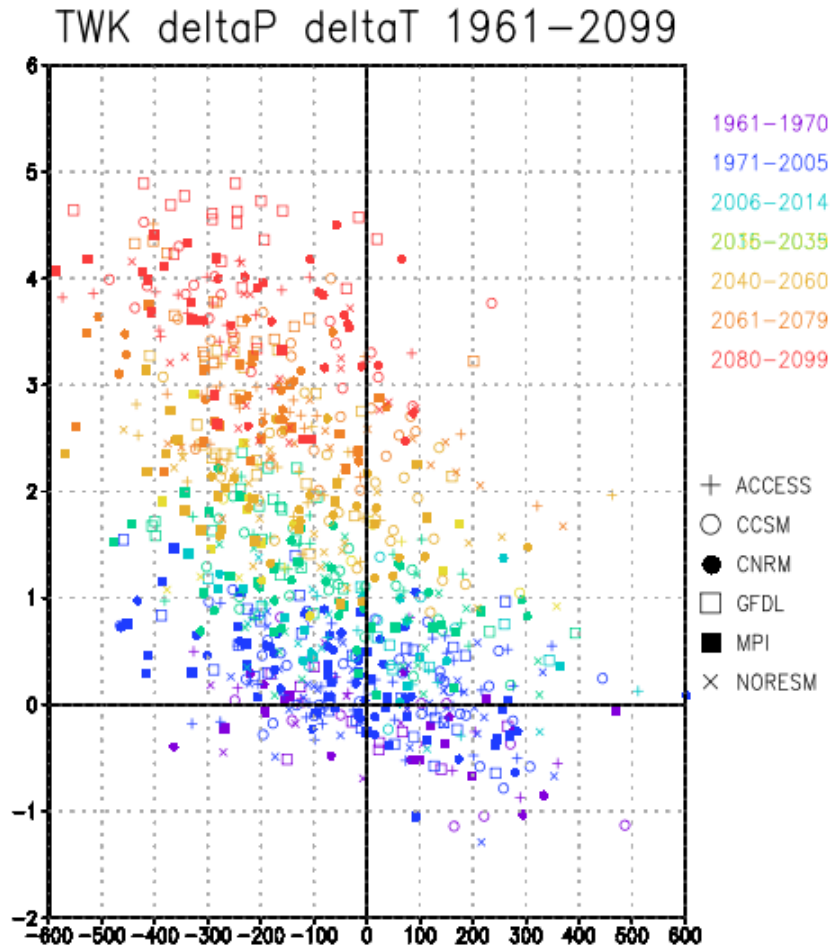
Projected changes in heavy rainfall events



An increase in extreme rainfall events can already be detected over eastern south Africa (observational trend over the last five decades; IPCC AR6 WGI report).

Most climate models project increases in intense rainfall events over South Africa's eastern escarpment areas under low mitigation climate change futures.

Figure shows the projected changes in the annual number of intense rainfall events (events causing more than 20 mm of rain over an area of 100 km²) across the ensemble of 9 CORDEX-core RCMs for 2080-2099 relative to 1981-2000.



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

Temperature increases of more than 4 ° C are plausible towards the end of the century under low mitigation futures

The region is projected to become substantially drier under low mitigation futures

Future climate change in southern Africa: key messages

- Southern Africa is warming drastically – over the interior regions the rate of warming is in the order of twice the global rate of warming.
- The region is likely to become generally drier, but rainfall futures over the eastern escarpment areas are uncertain.
- When a water-stressed, dry and warm region such as southern Africa becomes warmer and drier, the options for adaptation are limited.
- The ENSO (El Niño – La Niña) cycle in Africa is projected to intensify in terms of its impacts.
- We can expect more frequent, long-lasting droughts co-occurring with heatwaves of unprecedented intensity.
- Over eastern southern Africa, the number of extreme rainfall events are projected to increase in their frequency of occurrence.

Hawaii underestimated the deadly threat of wildfire, records show



By [Isabelle Chapman](#), [Scott Bronstein](#), [Casey Tolan](#) and [Allison Gordon](#), CNN

Updated 7:59 AM EDT, Sun August 13, 2023



In 2022, the Hawaii state emergency management agency described the risk of wildfires to human life with a single word: “low.”

Horrific Libya flooding made up to 50 times more likely by planet-warming pollution, scientists find

By Laura Paddison, CNN

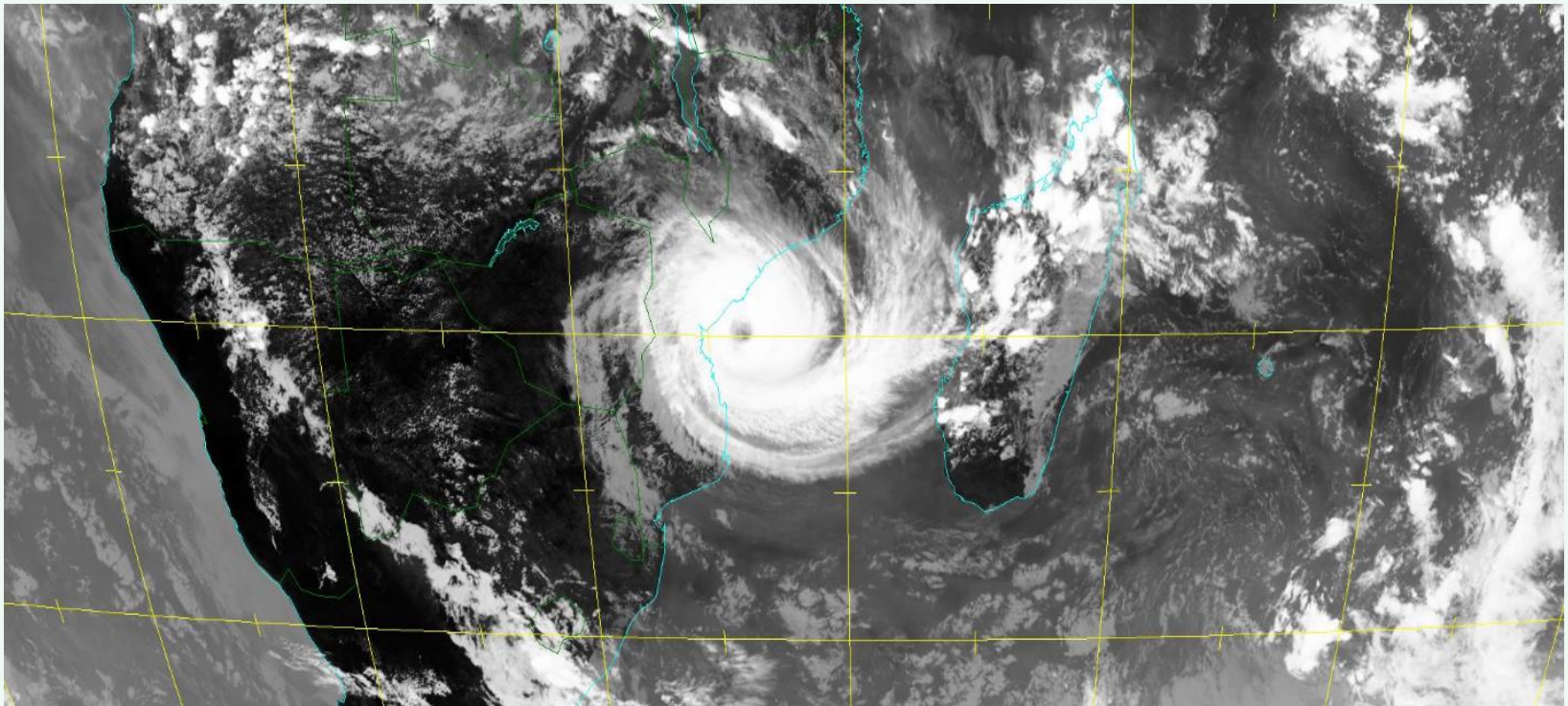
Published 9:00 AM EDT, Tue September 19, 2023



More than 11 000 people died in the flooding in the city of Derna in Libya in September 2023.

Recent devastating impacts of tropical cyclones in southern Africa and Madagascar: tropical cyclone Idai

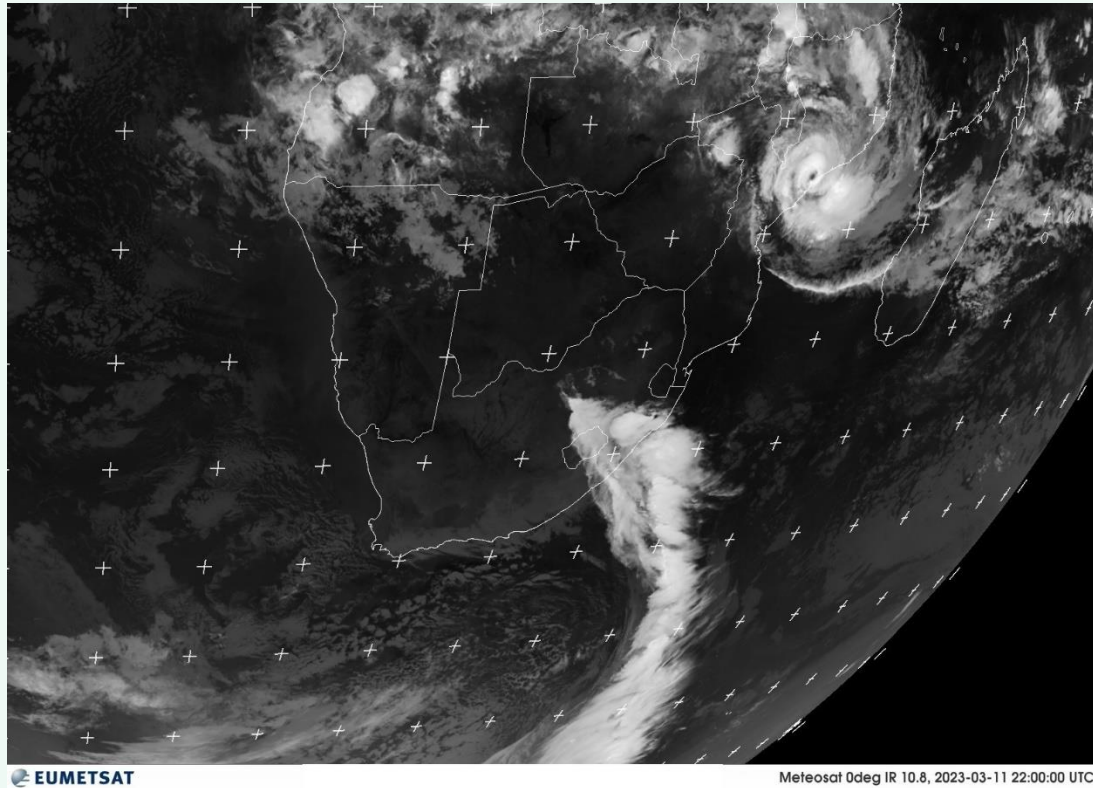
- Tropical cyclone Idai made landfall at Beira on 14 March 2019
- More than 1500 people died in the path of the storm
- Hundreds of people died in Beira because of a storm surge



Meteosat Second Generation (MSG) infra-red satellite image showing tropical cyclone Idai making landfall at Beira around midnight on 14 March 2019

Recent devastating impacts of tropical cyclones in southern Africa and Madagascar: tropical cyclone Freddy

- Tropical cyclone Freddy made landfalls in Madagascar and southern Africa in February and March 2023
- About 1500 people died in the path of the storm



Meteosat Second Generation (MSG) infra-red satellite image showing tropical cyclone Idai making landfall at Beira around midnight on 11 March 2023

Regional tipping points in Africa – we need more research and policy, including DRR plans for:

- A Gauteng day-zero drought – our biggest climate change risk in the near-term?
- More frequent and intense multi-year droughts, heat-waves and increase fire risk impacting on forestry, the maize crop, cattle industry and biodiversity – is there a point of biophysical/economic collapse for the various sectors?
- More frequent and intense heat-waves impacting on human health and mortality.
- Can an intense tropical cyclone (category 4/5 hurricane) reach Maputo or Richards Bay, or move down into the Limpopo River valley?



- With strong climate change mitigation, we can still avoid the 2 ° C threshold of global warming and related impacts.
- Climate change will bring unprecedented changes... but these should not be unforeseen: climate change science helps us to adapt and prepare (noting that there are also limits to adaptation).