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Medium to longterm climate change information to support adaptation in Africa

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Contributing Author to the IPCC SR1.5: Chapter 3

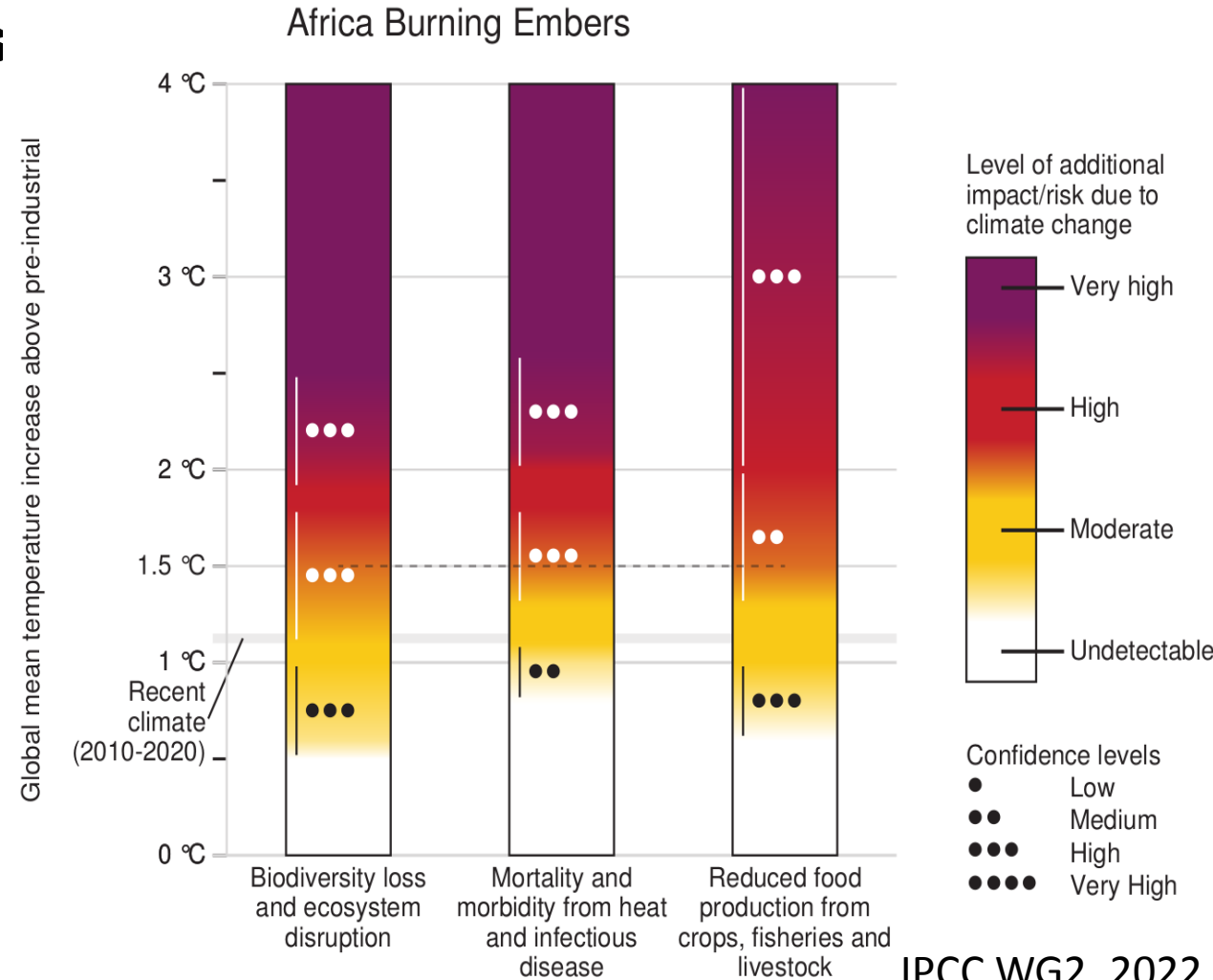


□ Africa:

➡ **Climate change hot spot where increases hazards probability, vulnerability and exposure meet: climate risk is high**

➡ **Recent studies (i.e. IPCC AR6 SR1.5):**

- Risk increases with respect to global warming level
- Risk for biodiversity loss and ecosystem disruption increases faster
- At 4°C, all risks are equal and very high



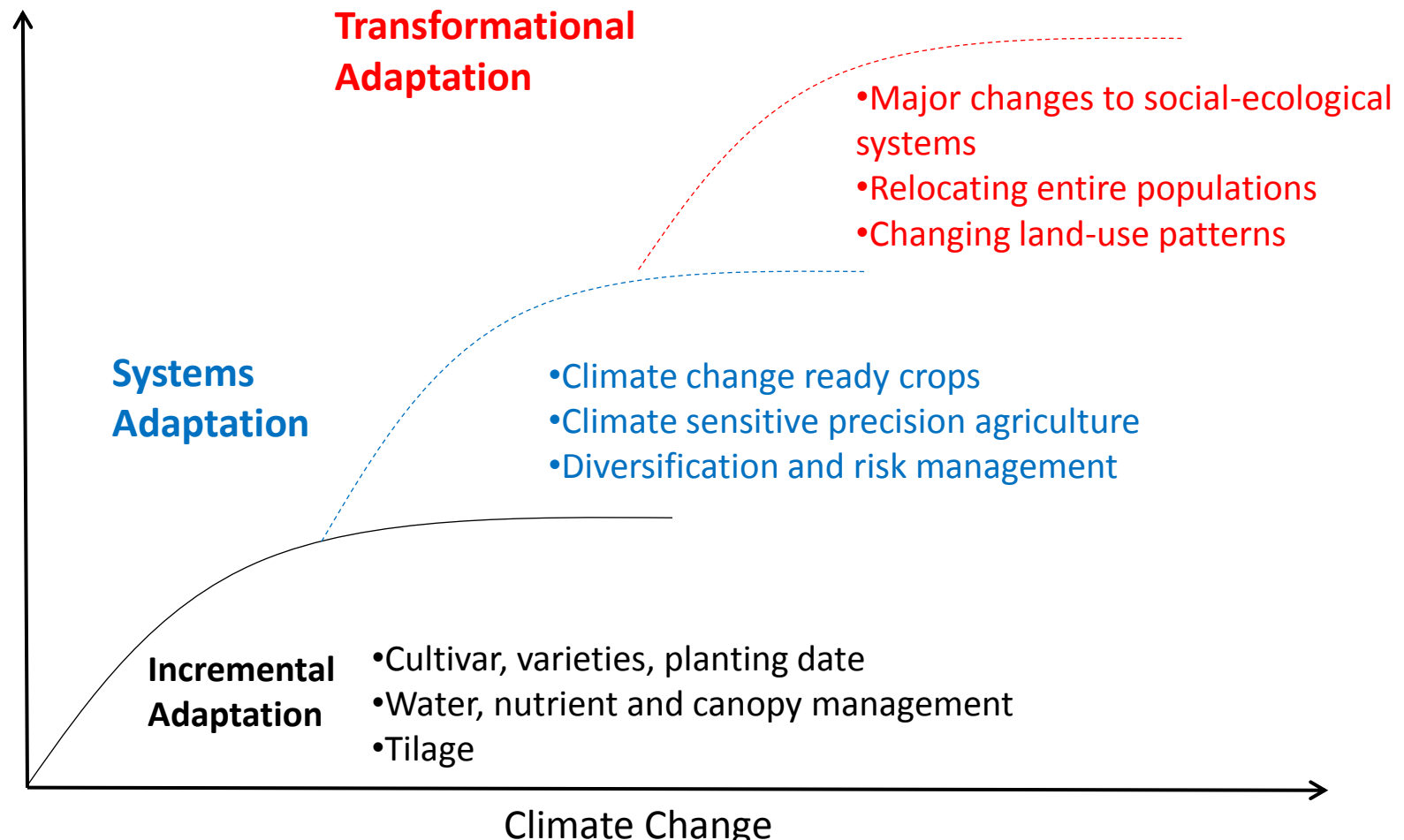


Climate change information VS adaptation

Changes for dealing with the more severe impacts of climate change further in the future

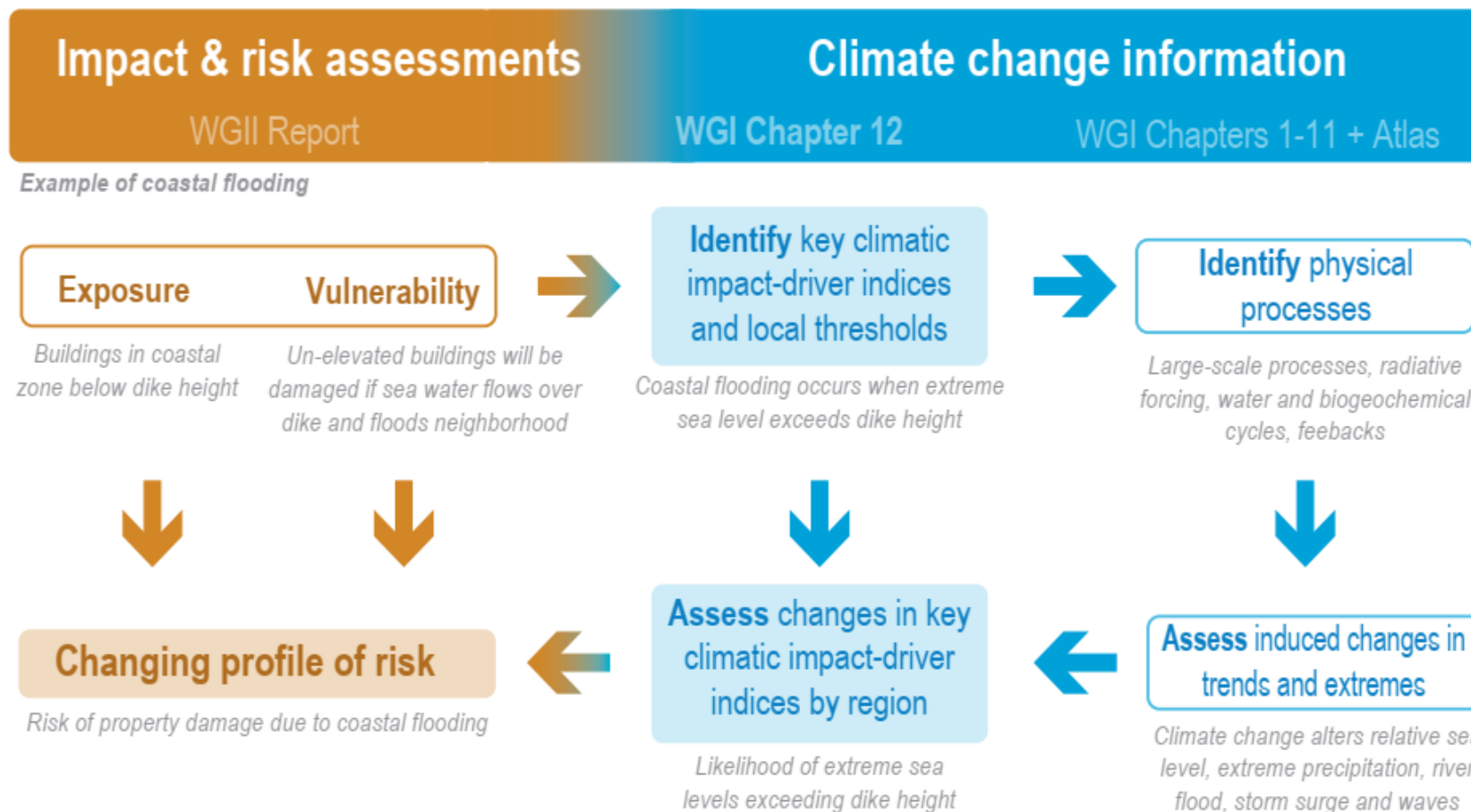
Medium-term adaptations, which deal with near-term climate change

Short-term adaptations which enable better coping with current climate variability





Climate change Information in IPCC Risk Assessment Framework



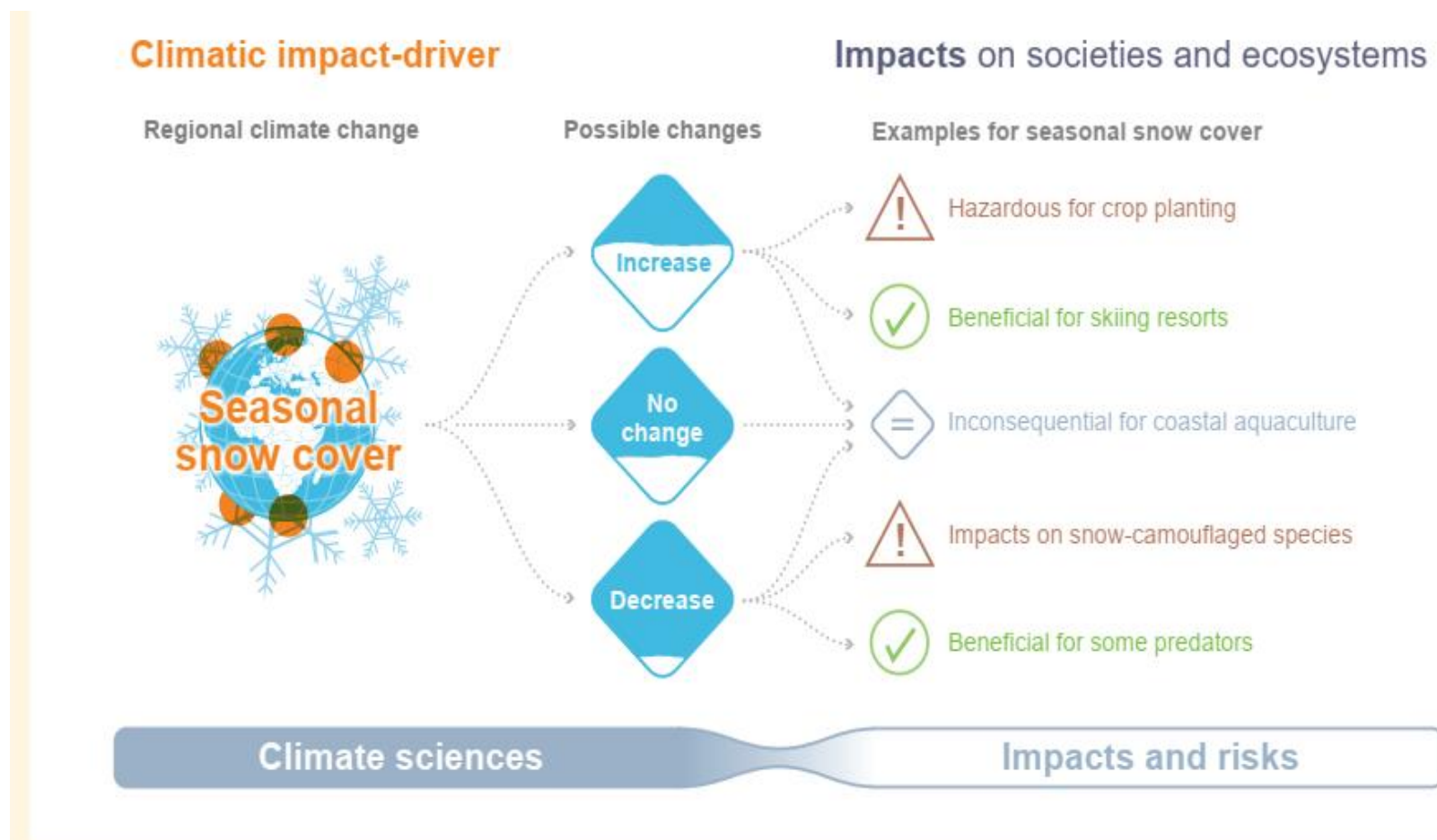
IPCC WG1, 2021

A bunch of climate change information indices have been developed, most which are based on a tolerance threshold exceedance

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➤ Climatic Impact-drivers (CID)

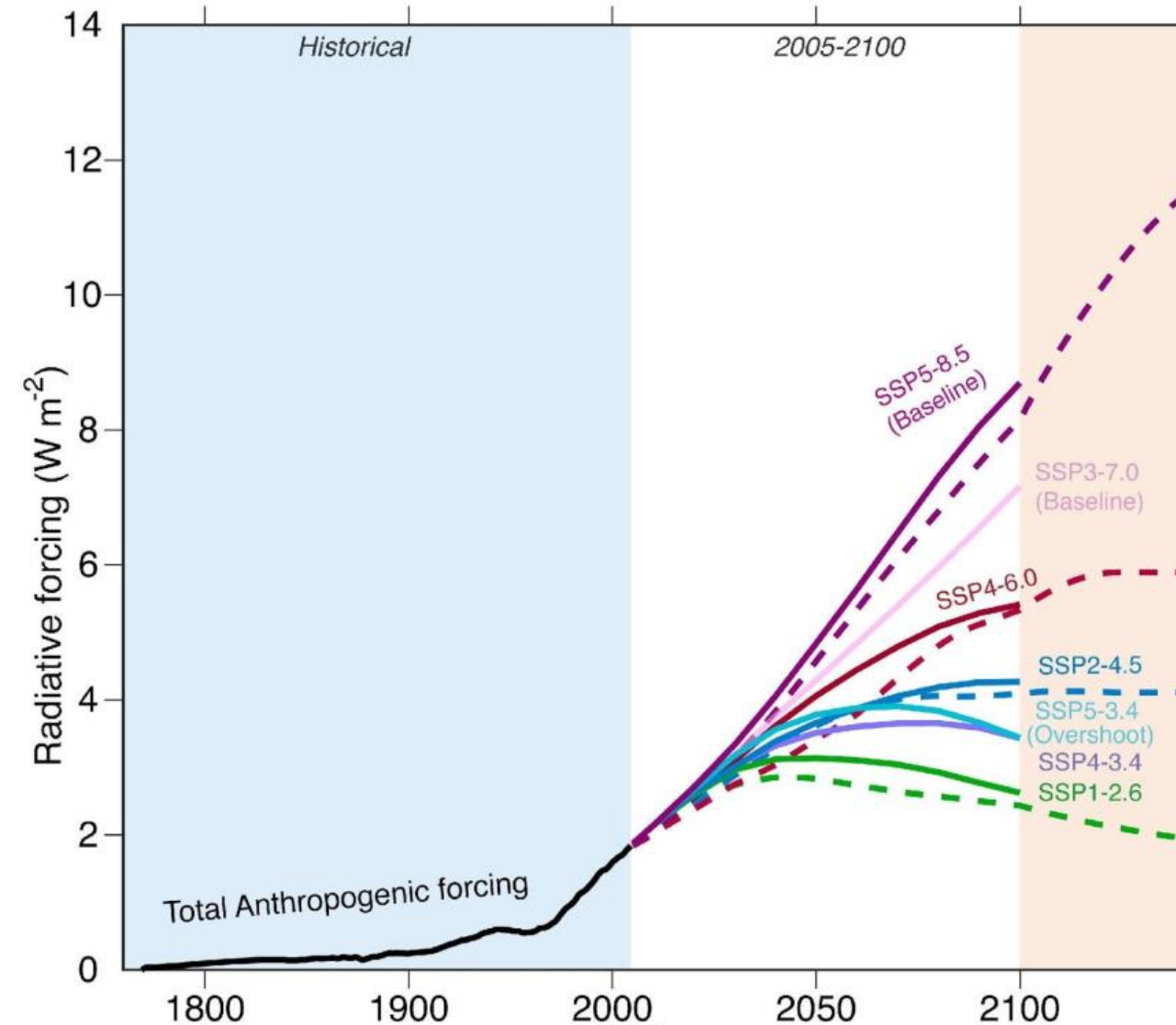
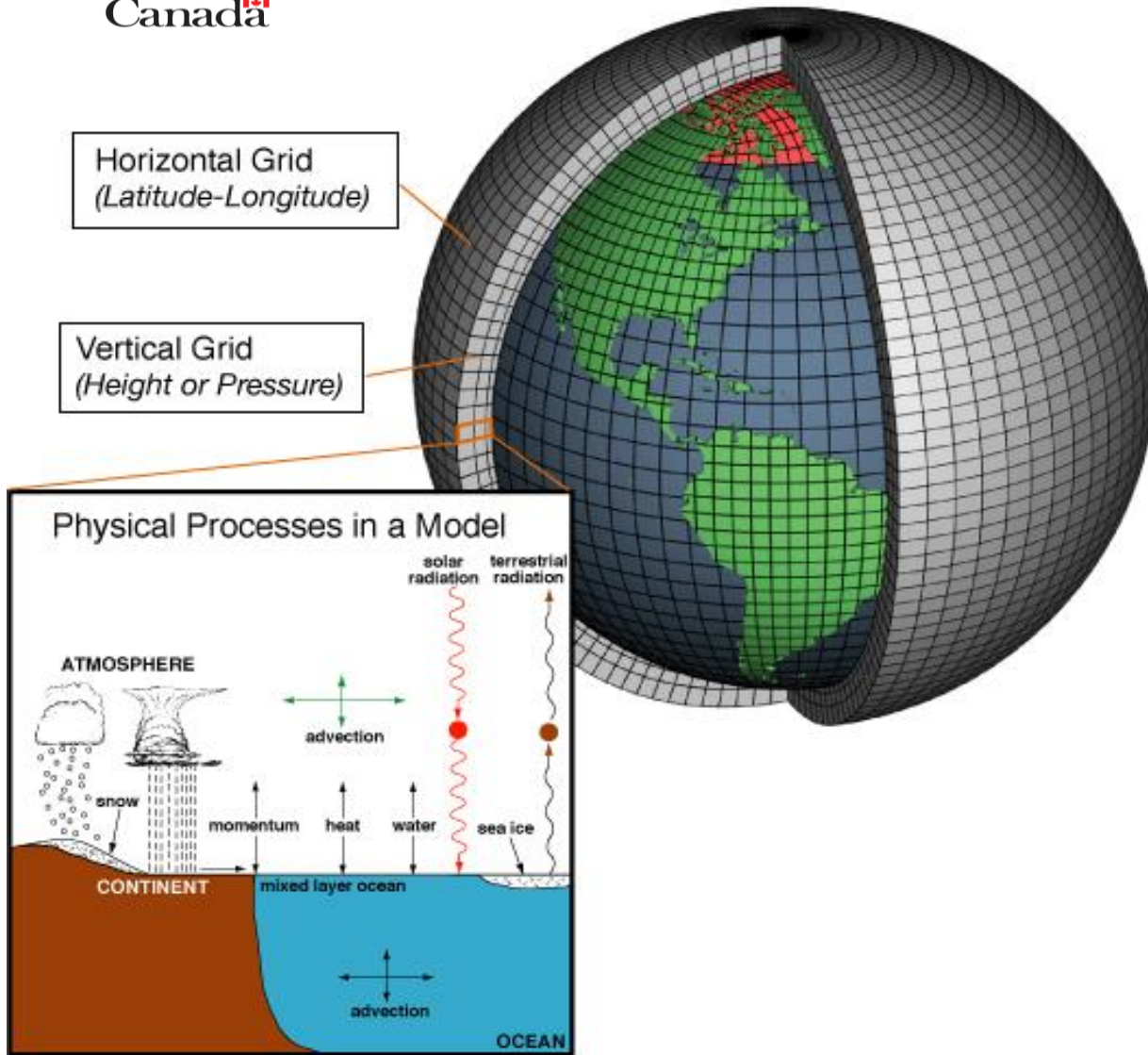
- **CID is a climate condition that directly affects elements of society or ecosystems**
- **CIDs and their changes can lead to positive, negative or inconsequential outcomes (or a mixture)**



➤ Climatic Impact-drivers (CID)

- CID is a climate condition that directly affects elements of society or ecosystems
- CIDs and their changes can lead to positive, negative or inconsequential outcomes (or a mixture)
- Each CID is relevant for one or many sectors/assets

		Climatic Impact-driver																																		
		Heat and Cold			Wet and Dry					Wind		Snow and Ice				Coastal		Open Ocean			Other															
Sector	Asset	Mean air temperature	Extreme heat	Cold spell	Frost	Mean precipitation	River flood	Heavy precipitation and pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural and ecological drought	Fire weather	Mean wind speed	Severe wind storm	Tropical cyclone	Sand and dust storm	Snow, glacier and ice sheet	Permafrost	Lake, river and sea ice	Heavy snowfall and ice storm	Hail	Snow avalanche	Relative sea level	Coastal flood	Coastal erosion	Mean ocean temperature	Marine heatwave	Ocean acidity	Ocean salinity	Dissolved oxygen	Air pollution weather	Atmospheric CO ₂ at surface	Radiation at surface		
Food, Fibre and Other Ecosystem Products (WGII Chapter 5)	Crop systems																																			
	Livestock and pasture systems																																			
	Forestry systems																																			
	Fisheries and aquaculture systems																																			
Cities, Settlements and Key Infrastructure (WGII Chapter 6)	Cities																																			
	Land and water transportation																																			
	Energy infrastructure																																			
	Built environment																																			
Health, Well-being and Communities (WGII Chapter 7)	Labour productivity																																			
	Morbidity																																			
	Mortality																																			
	Recreation and tourism ^a																																			
Poverty, Livelihoods and Sustainable Development (WGII Chapter 8)	Housing stock ^b																																			
	Farmland ^b																																			
	Livestock mortality ^b																																			
	Indigenous traditions																																			



Schematic of Climate Models

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➡ CMIP6: GCMs and ESMs

- For climate change studies: Historical, ScenarioMIP, HighResMIP
- More than 30 GCMs/ESMs have made available daily data
- SSP1-2.6; SSP2-4.5; SSP5-8.5

➡ CORDEX: RCMs

- For climate change studies: Evaluation, Historical and Projections – Downscaling CMIP5
- More than 20 RCMs experiments available
- RCP4.5, RCP8.5

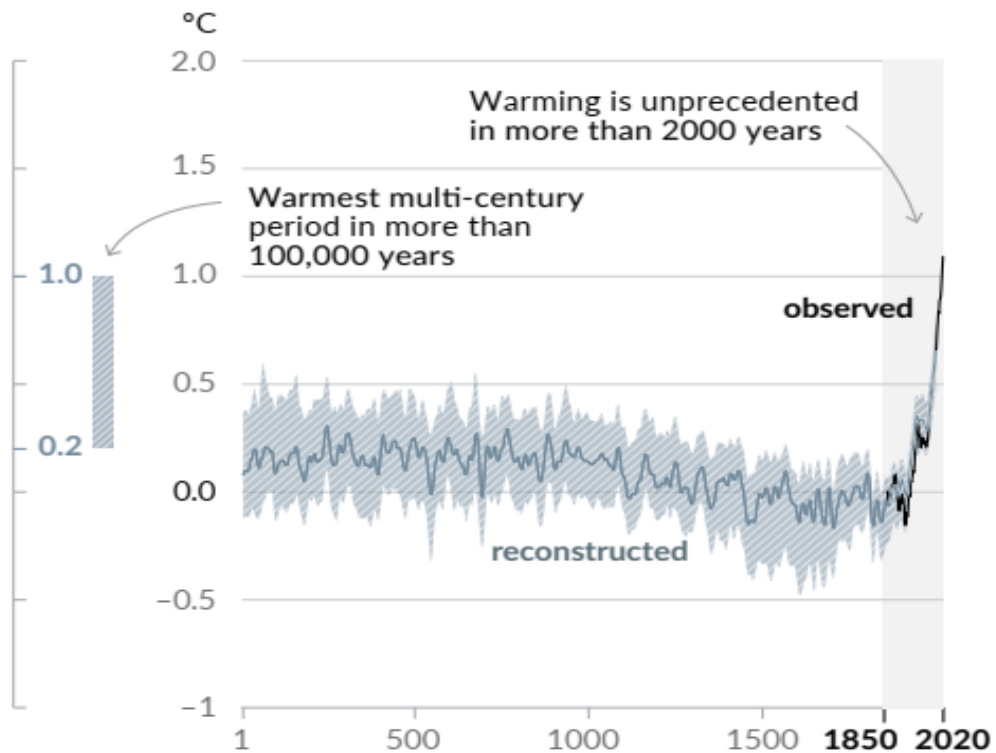
➡ CORDEX2: Downscaling CMIP6 – about to start

	Grand science challenges									
	Response to Forcing	Systematic Errors	Questions Variability, Prediction & Projection	Clouds, circulation, sensitivity	Melting ice	Climate extremes	Changes in water availability	Regional sea level change	Biogeochemistry	Near term prediction
AerChemMIP	●		○					●		○
C4MIP	●		○				○	●		
CFMIP	●	○		●			○			
DAMIP	●		○		○	●				
DCPP	○		●				○			●
FAFMIP	●	○		○			●			
GeoMIP	○		●	●		○	○			
GMMIP		●	○	●			○			○
HighResMIP	○	●		○			●			
ISMIP6	●		○		●			●		
LS3MIP	○	●			○		●			
LUMIP	●		○				○		●	
OMIP		●	○					○	○	●
PMIP	●	○		●				○		○
RFMIP	●		○	●						○
ScenarioMIP	○		●			●	●		○	
VolMIP	●	○		○						○
CORDEX	○		●			●	○			
DynVarMIP	○	●		○						○
SIMIP	○	●			●					
VIACS AB	○		●			●	○	○		

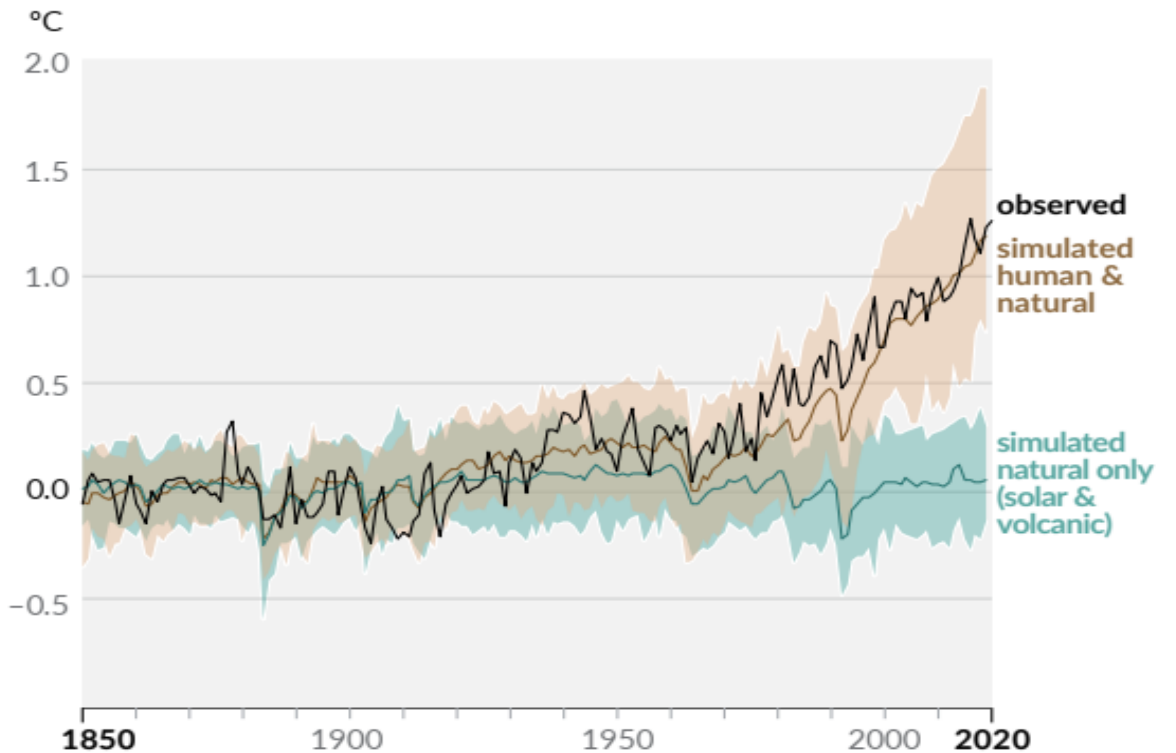
□ Climate change vs Global warming

IPCC WG1, 2021

(a) Change in global surface temperature (decadal average) as **reconstructed** (1–2000) and **observed** (1850–2020)



(b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)

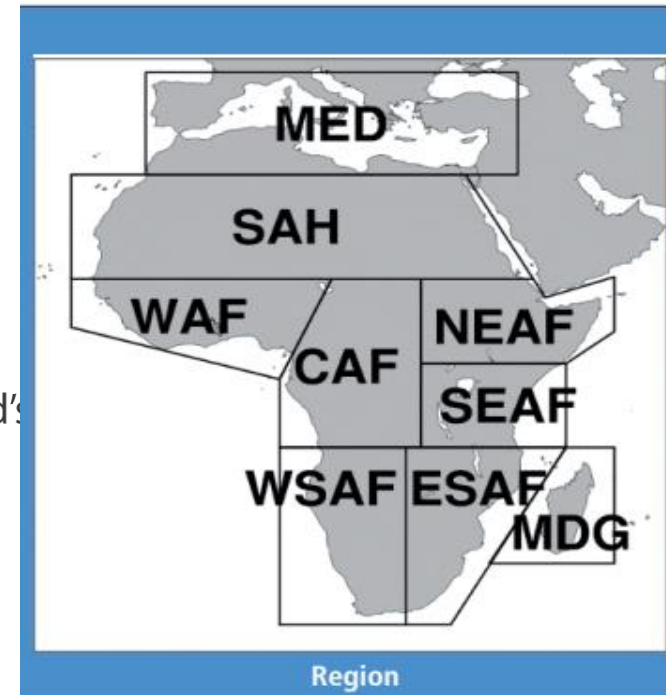


Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

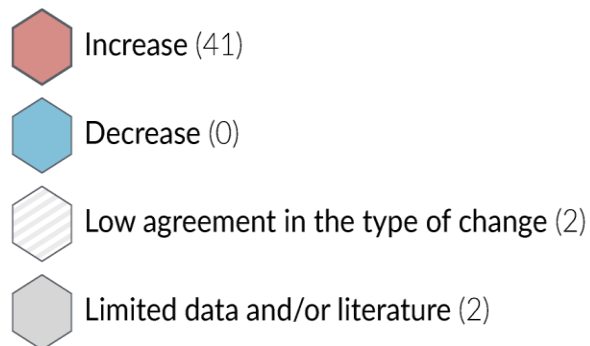
III/ State-of-the-Art

Extreme heat

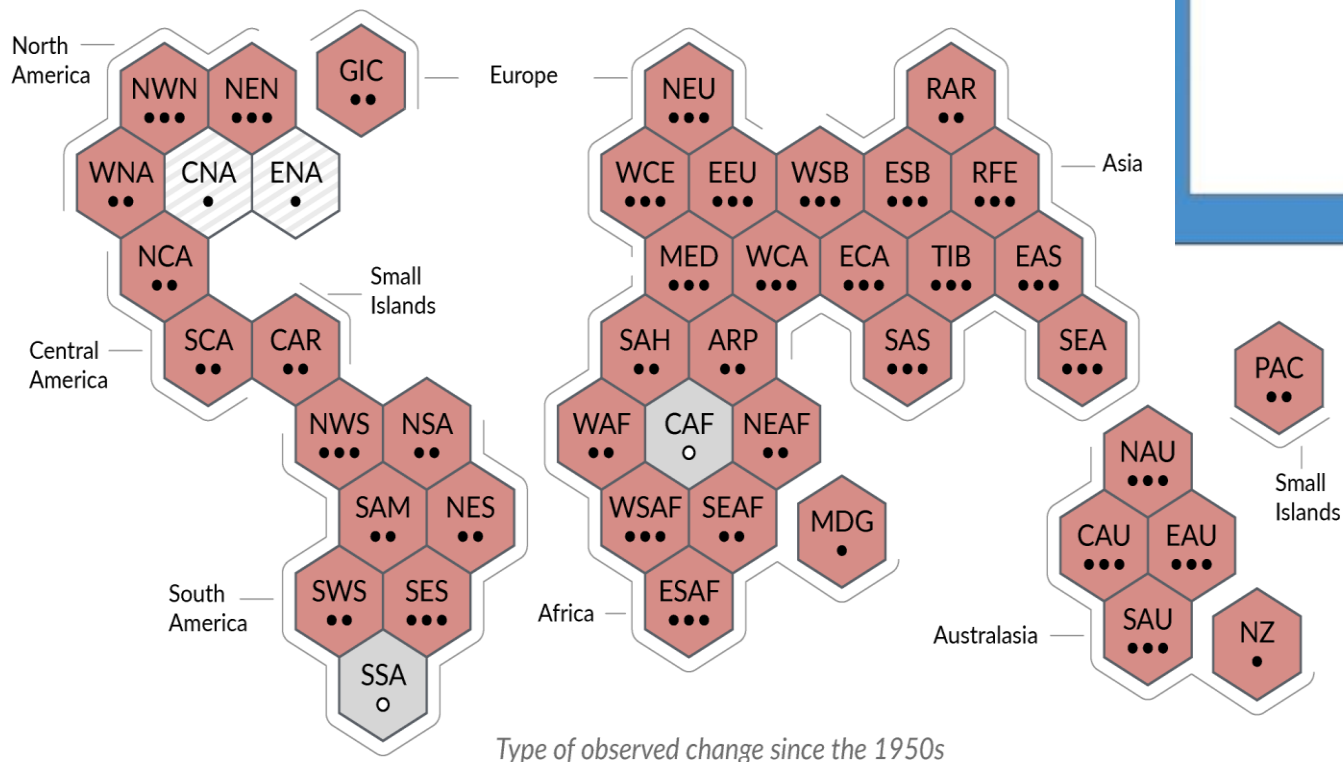
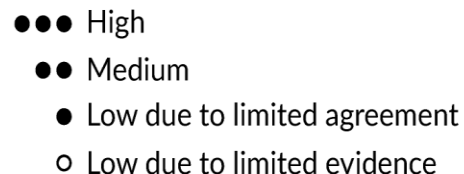
a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's



Type of observed change in hot extremes



Confidence in human contribution to the observed change

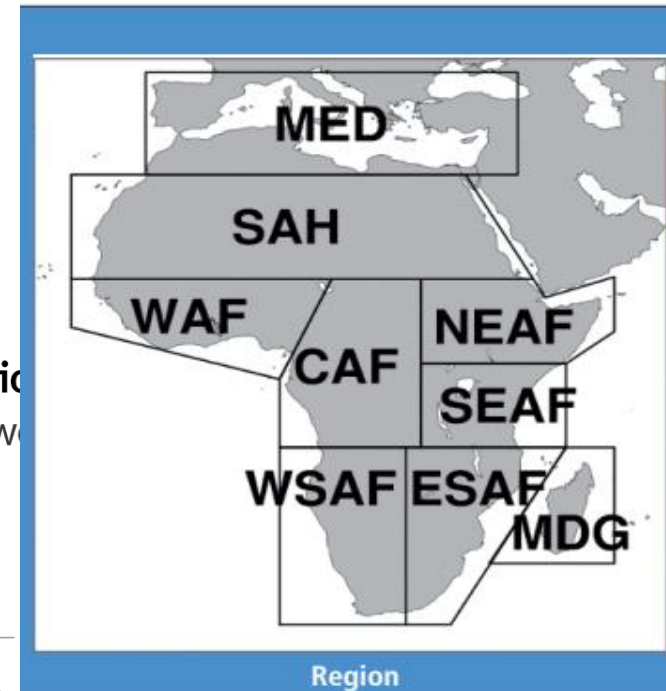


Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

III/ State-of-the-Art

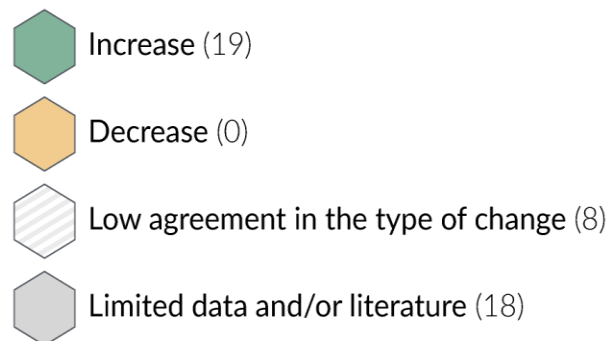


□ Heavy precipitation that can lead to floods

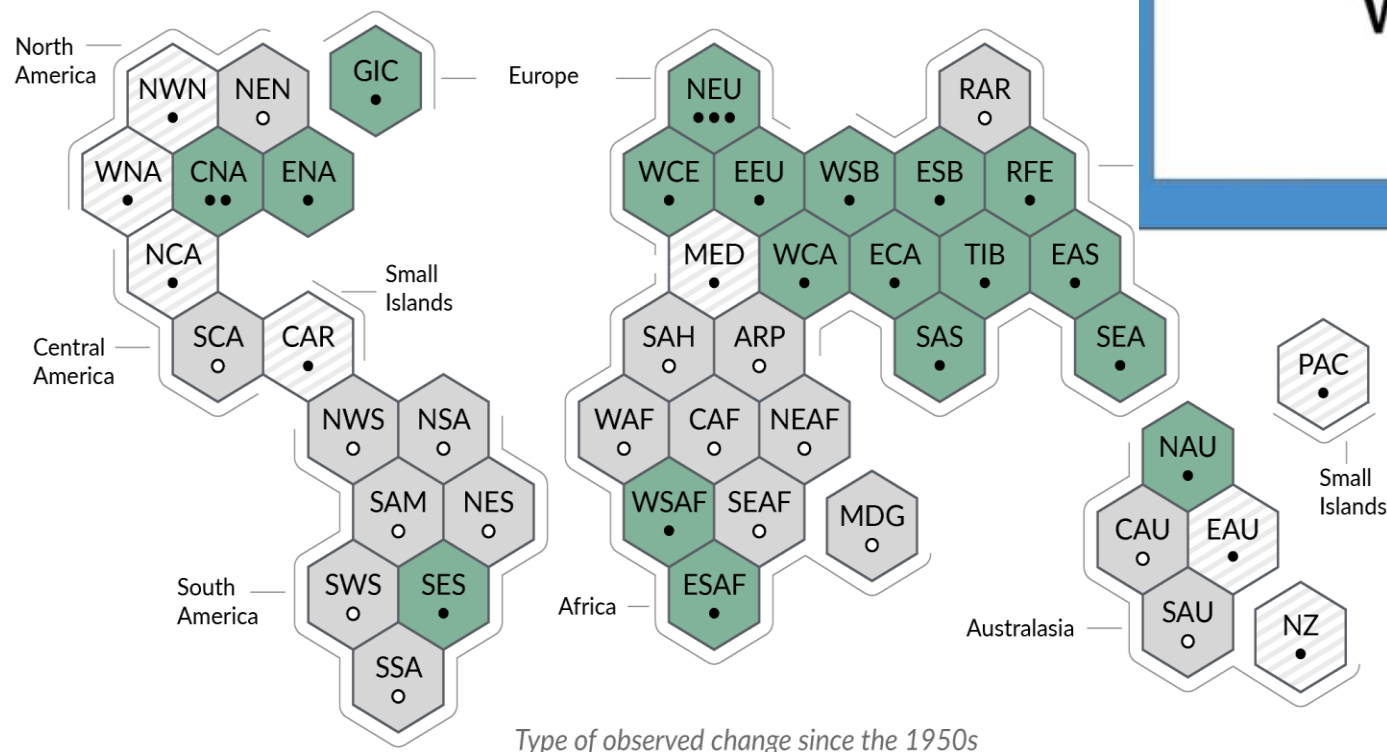
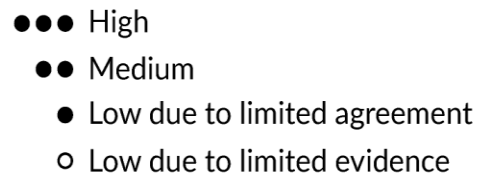


b) Synthesis of assessment of observed change in heavy precipitation confidence in human contribution to the observed changes in the w

Type of observed change in heavy precipitation



Confidence in human contribution to the observed change



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III/ State-of-the-Art

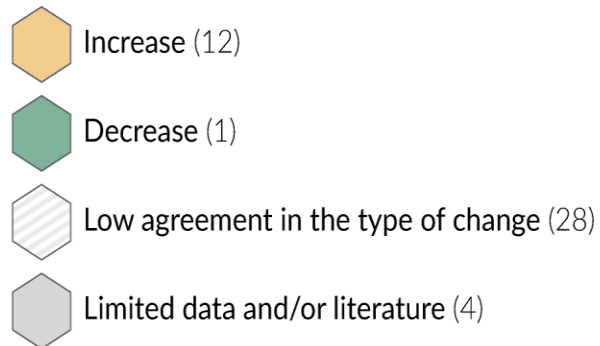


□ Different types of droughts

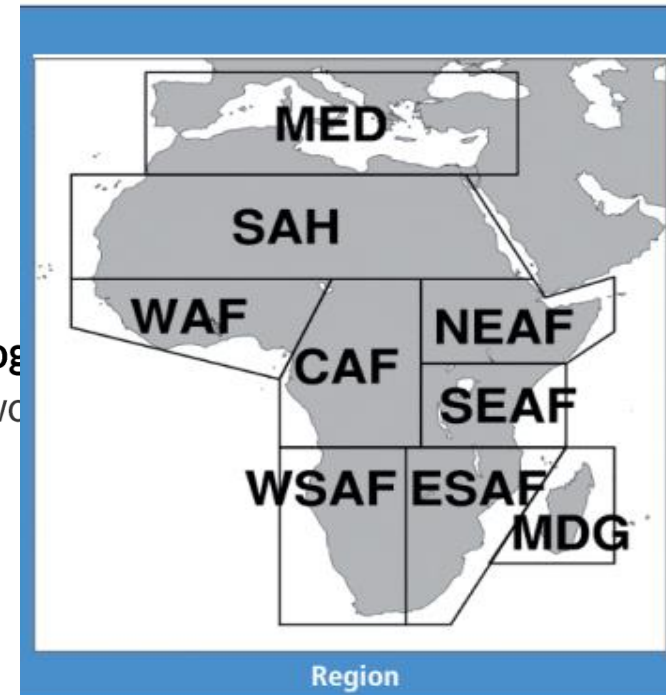
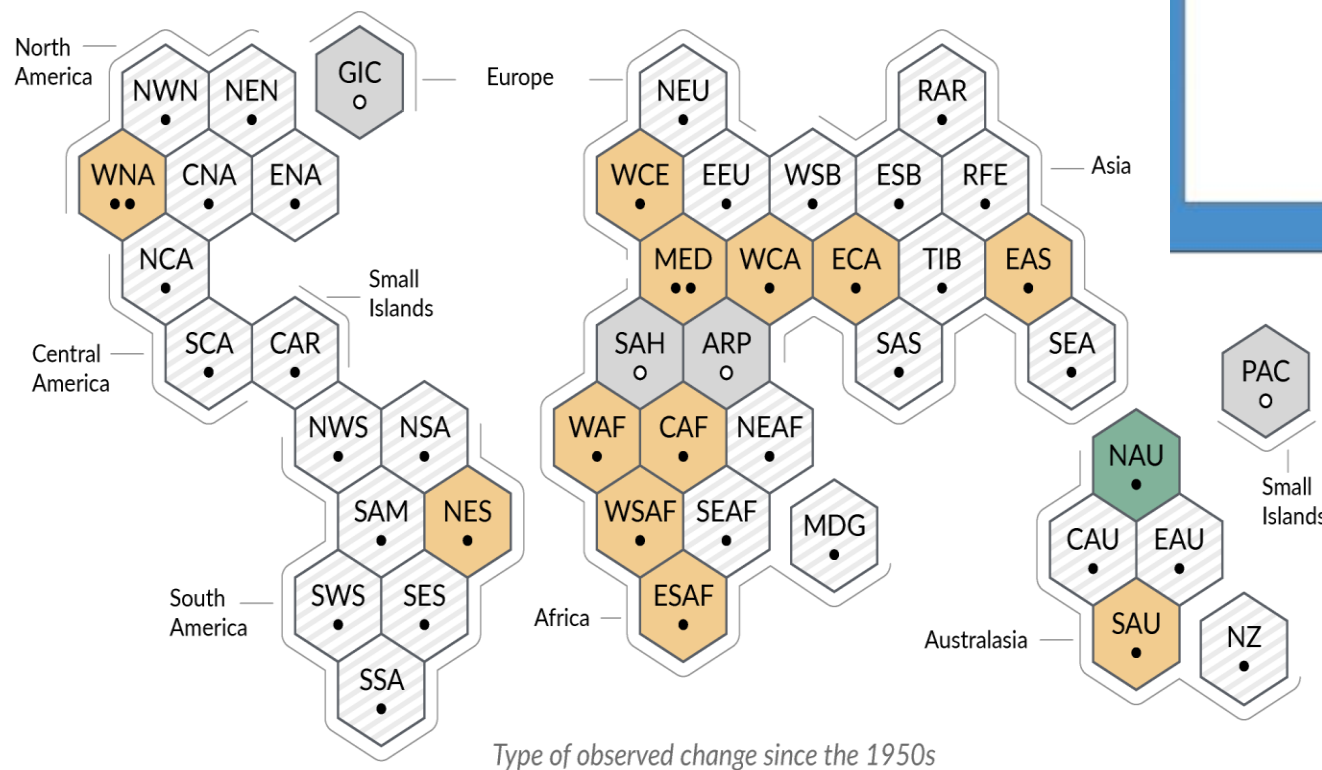
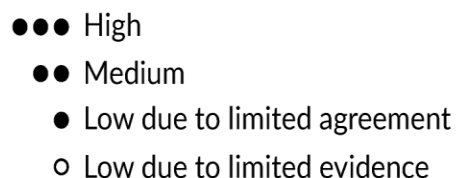
c) Synthesis of assessment of observed change in agricultural and ecological drought and confidence in human contribution to the observed changes in the world

Type of observed change

in agricultural and ecological drought



Confidence in human contribution to the observed change

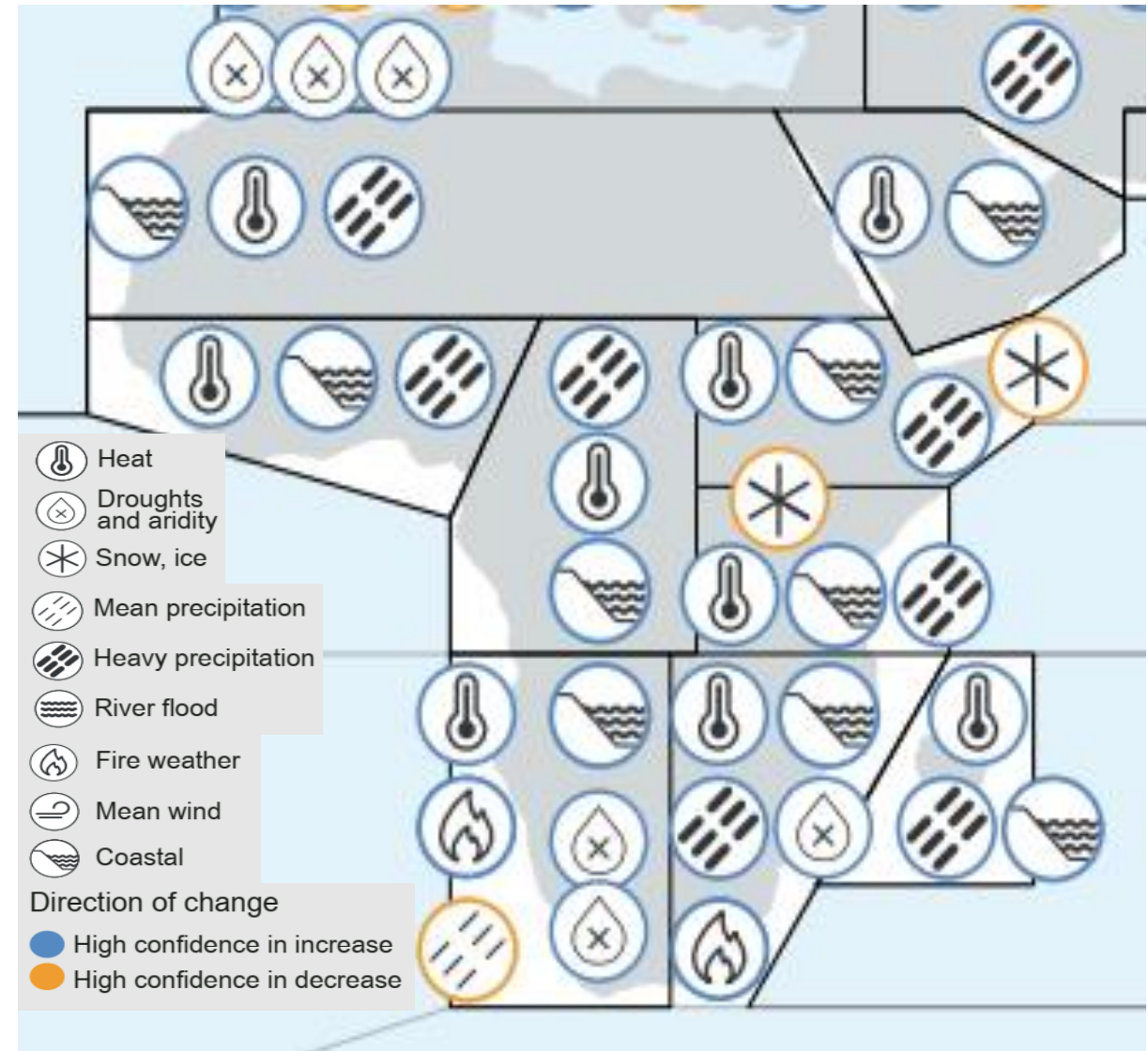


Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

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Multiple climatic impact-drivers are projected to change in all regions of the world, especially in Africa

- Most common changes: Heat, Coastal and Heavy Precipitation
- Southern Africa: Drought and Fire Weather are added
- Eastern Africa: Decreased Snow/Ice coverage emerges are added



- Link extreme heat indices to human, animal and plant health
- Populate the African literature with more heat indices – increase the level of confidence !
- Population and ecosystems exposure and how heat impacts work productivity and energy demand – quantification !
- Energy demand is completely missing from CIDs – Yet very critical for Africa – Just transition
- Literature related to drought issues in Africa has a lot of gaps. Rather than taking a general trend and averaging over a large domain, needs to disentangle spatially and temporally – change narrative

IV/ Some Gaps

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- Aridity is completely in the low confidence side – Need to look into biomes exposure
- No attempts to link extreme precipitation to floods – large a large gaps about flood drivers in present-day and occurrence in the future
- Landslides, River flooding, Fire weather, Windstorm, Dust and Sandstorm, Tropical cyclones
- Invest more in the behavior of these CIDs under global warming of 1.5C, 2C, 2.5C, 3C, etc. – to inform AGN

V/ FILLING THE GAPS

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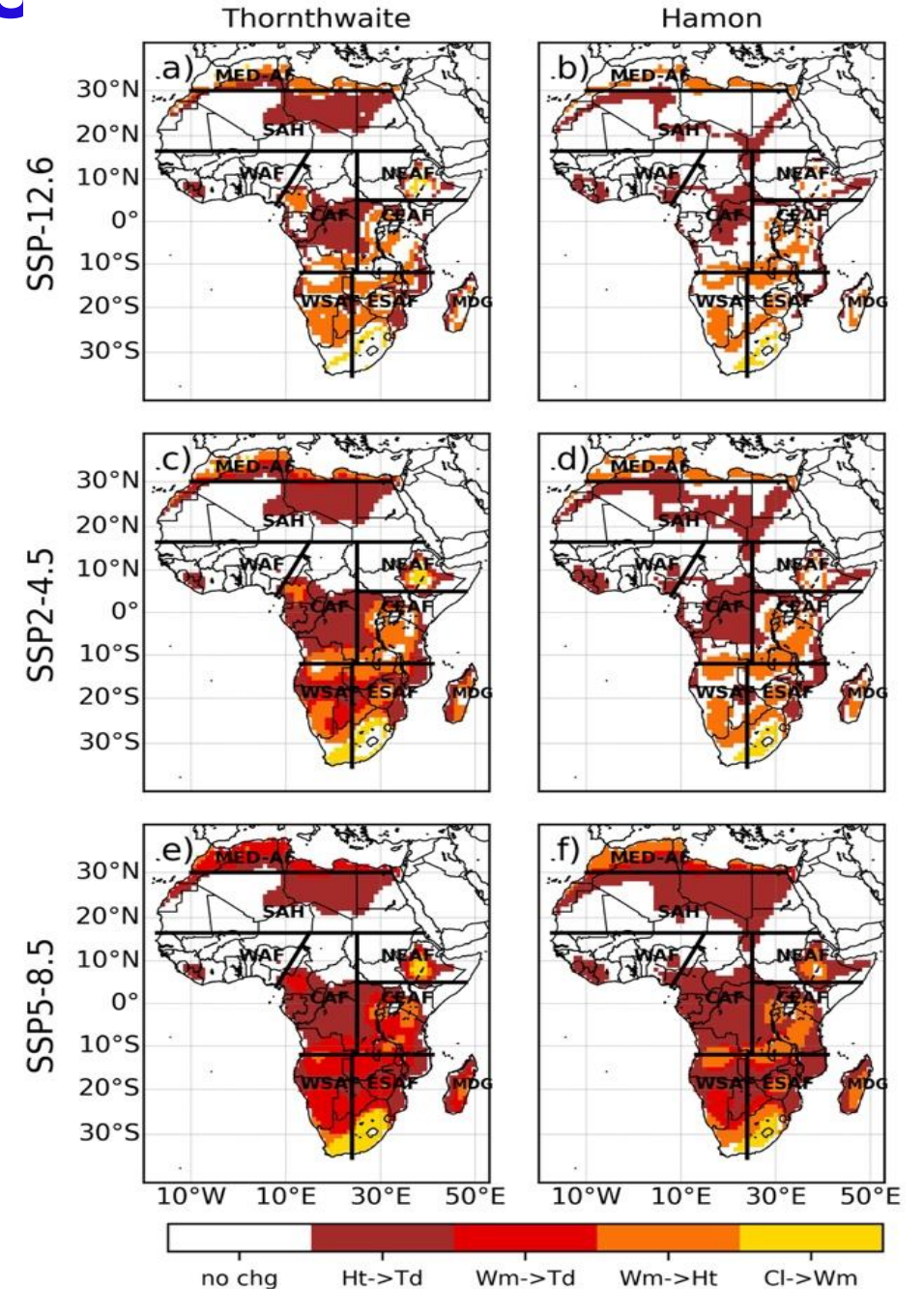
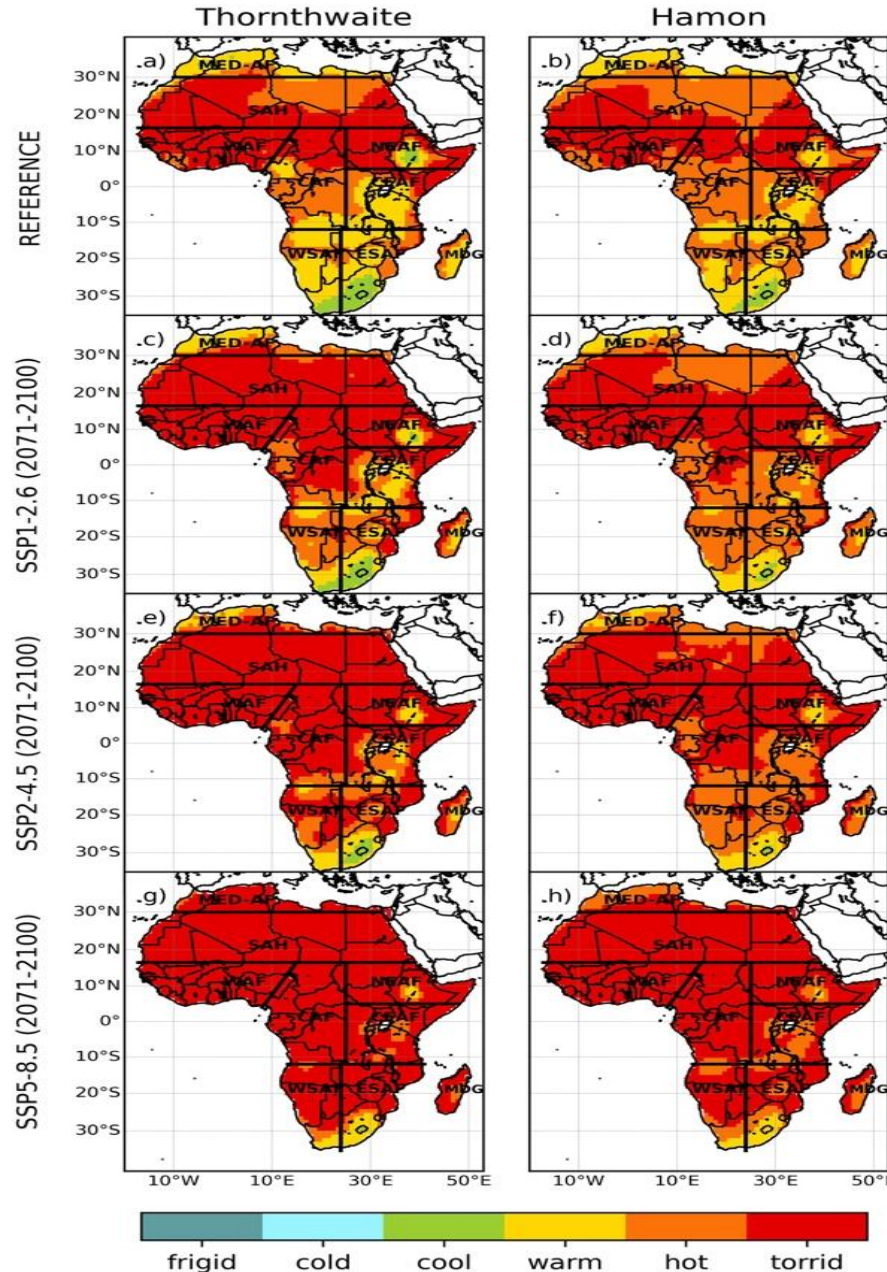
Extreme Heat

$$PET = 16 * N * \left(\frac{10T}{I}\right)^a$$

$$I = \sum_{i=1}^{12} I_i$$

$$I_i = \left(\frac{T_{mean,i}}{5}\right)^{1.514}$$

$$a = 6.75 * 10^{-7} * I^3 - 7.71$$

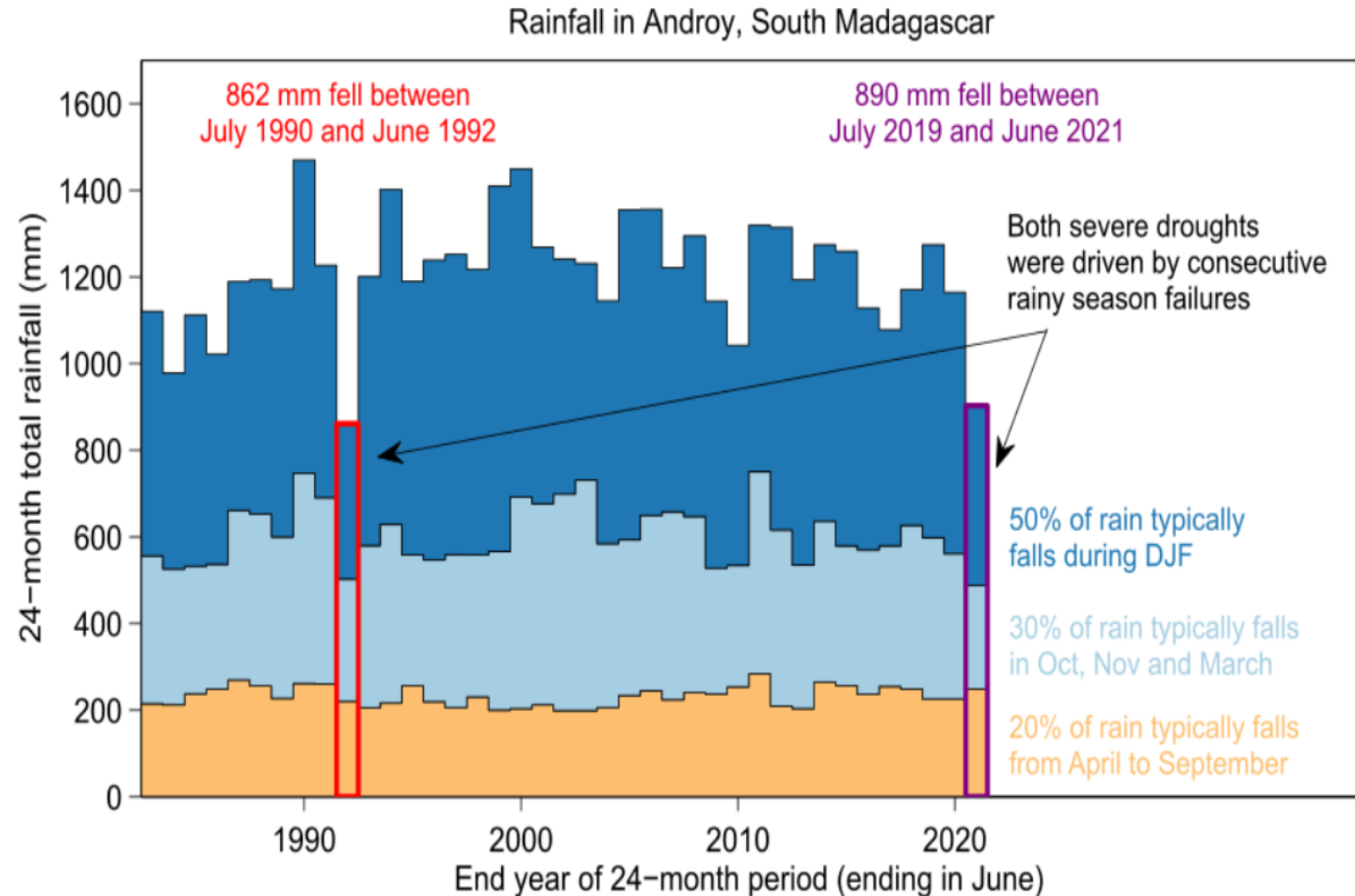


V/ FILLING THE GAPS

□ Issue of attribution

- Drought over Madagascar

- The rainy seasons of both 2019/20 and 2020/21 saw just 60% of normal rainfall across the Grand Sud region
- This lack of rain over the 24 months from July 2019 to June 2021 was estimated as a 1-in-135 year dry event
- Only surpassed in severity by the devastating drought of 1990-92
- Drought events attributed to natural variability
- Any drought events due to human activity in this region will emerge above 2°C of Global Warming (IPCC 2021)



V/ FILLING THE GAPS

□ Issue of attribution

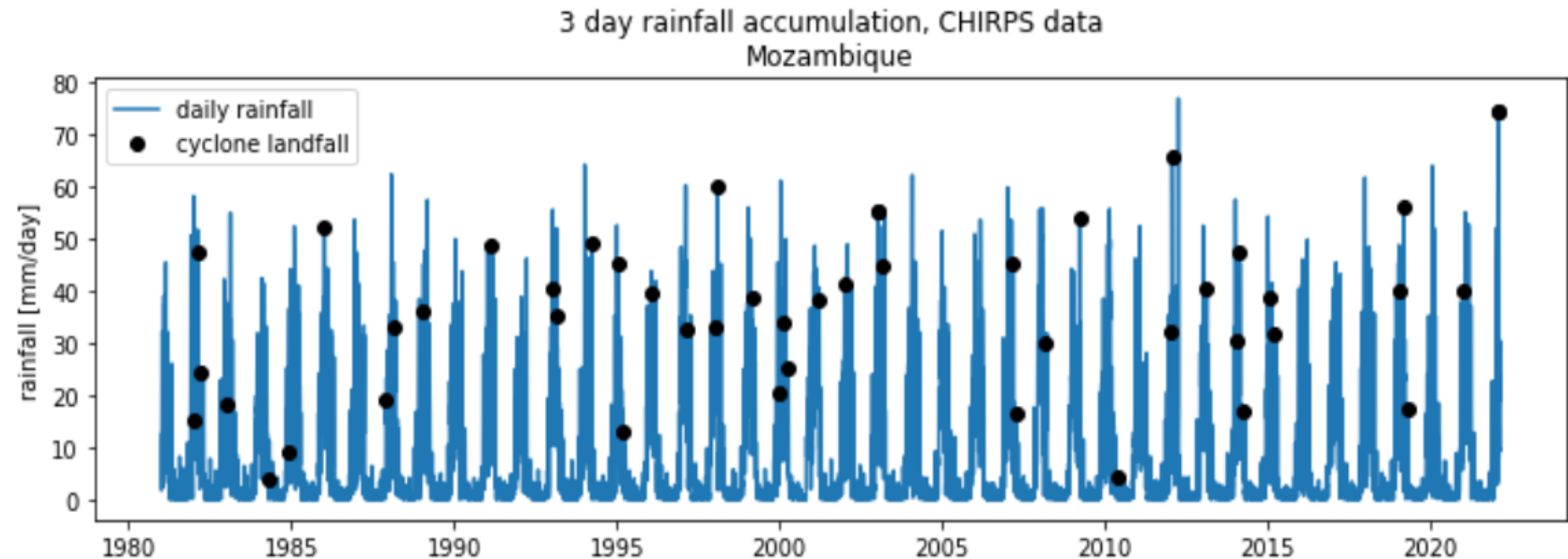
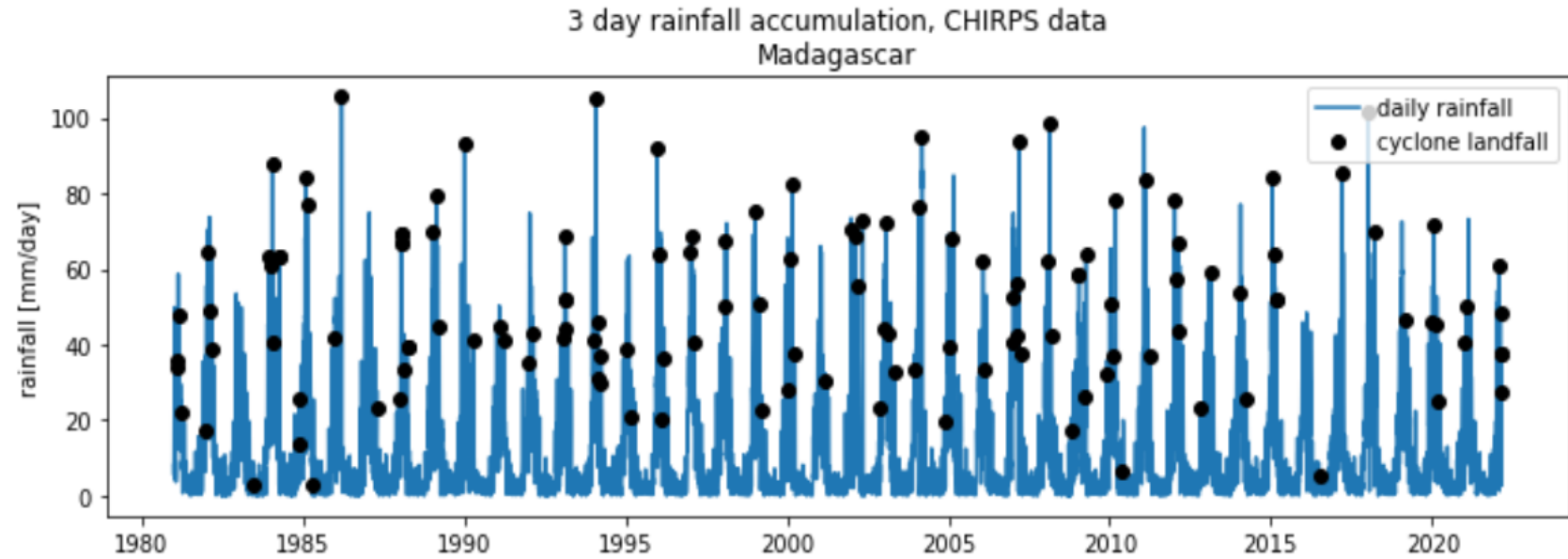
- Extreme precipitation associated to tropical cyclones over southeastern Africa

- Ana, with a return period of approx. 1 in 50 years over Malawi and Mozambique

- Batsirai was not a rare event: 1 in 2 years over Madagascar

- Climate change indeed increased the likelihood and intensity of the rainfall associated with Ana and Batsirai

Otto et al. 2023





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Thank you for your attention

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