CONFÉRENCE SCIENTIFIQUE INTERNATIONALE SUR LE CHANGEMENT CLIMATIQUE • NIAMEY (NIGER)

AIMS African Institute for Mathematical Sciences RESEARCH & INNOVATION

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Modeling climate extremes over West Africa and the Sahel

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I/ The Context

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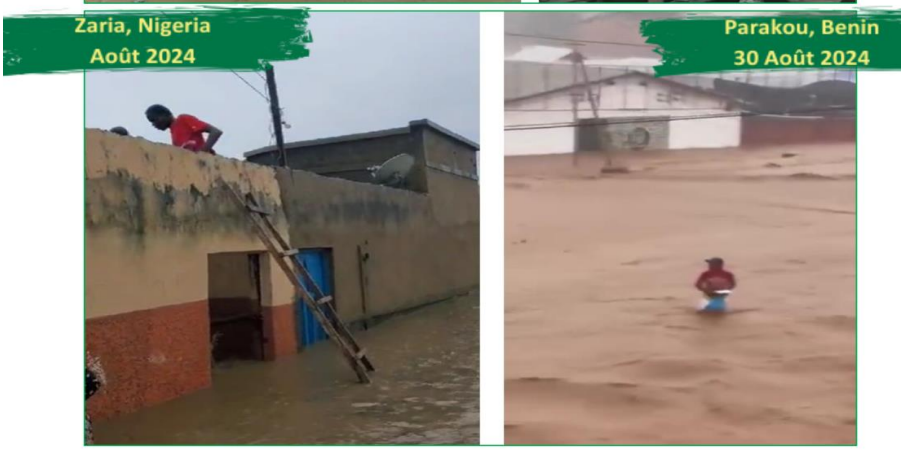
❑ Africa:

The African Academy of Sciences · ACMAD · ACPC African Climate Policy Centre · CGIAR AICCRA · AIMS African Institute for Mathematical Sciences RESEARCH & INNOVATION · African Union · Food and Agriculture Organization of the United Nations · INDIAN OCEAN COMMISSION · LEGOS · NILE BASIN INITIATIVE INITIATIVE DU BASSIN DU NIL · NOR CAP PART OF NORWEGIAN REFUGEE COUNCIL · ECA · IGAD ICPAC · Deutscher Wetterdienst Wetter und Klima aus einer Hand DWD

- Temperature increases
- Multi-year droughts continued
- Extreme heat and floods hit
- Increasing climate change bill
- Early warnings for all

I/ The Context …

AGRHYMET, 2024: Note Technique



As the climate warms…

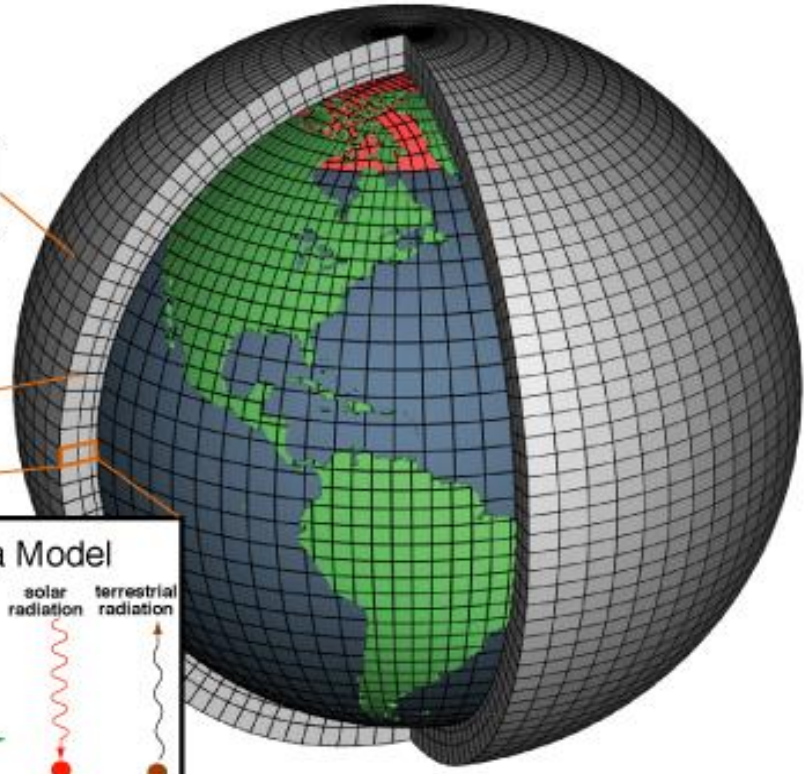
Africa will have to brace in the future for more hazards that will lead to disasters

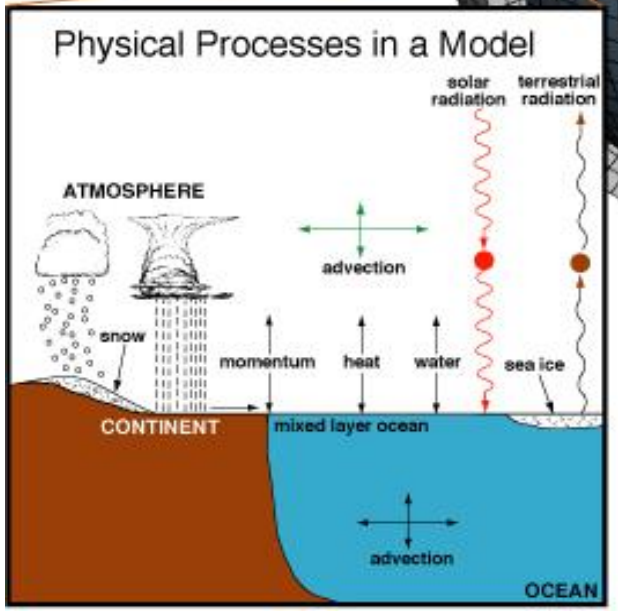
Or to prepare for new opportunities

↓

Robust climate information
EW4A ---> DRR

II/ Climate Modeling

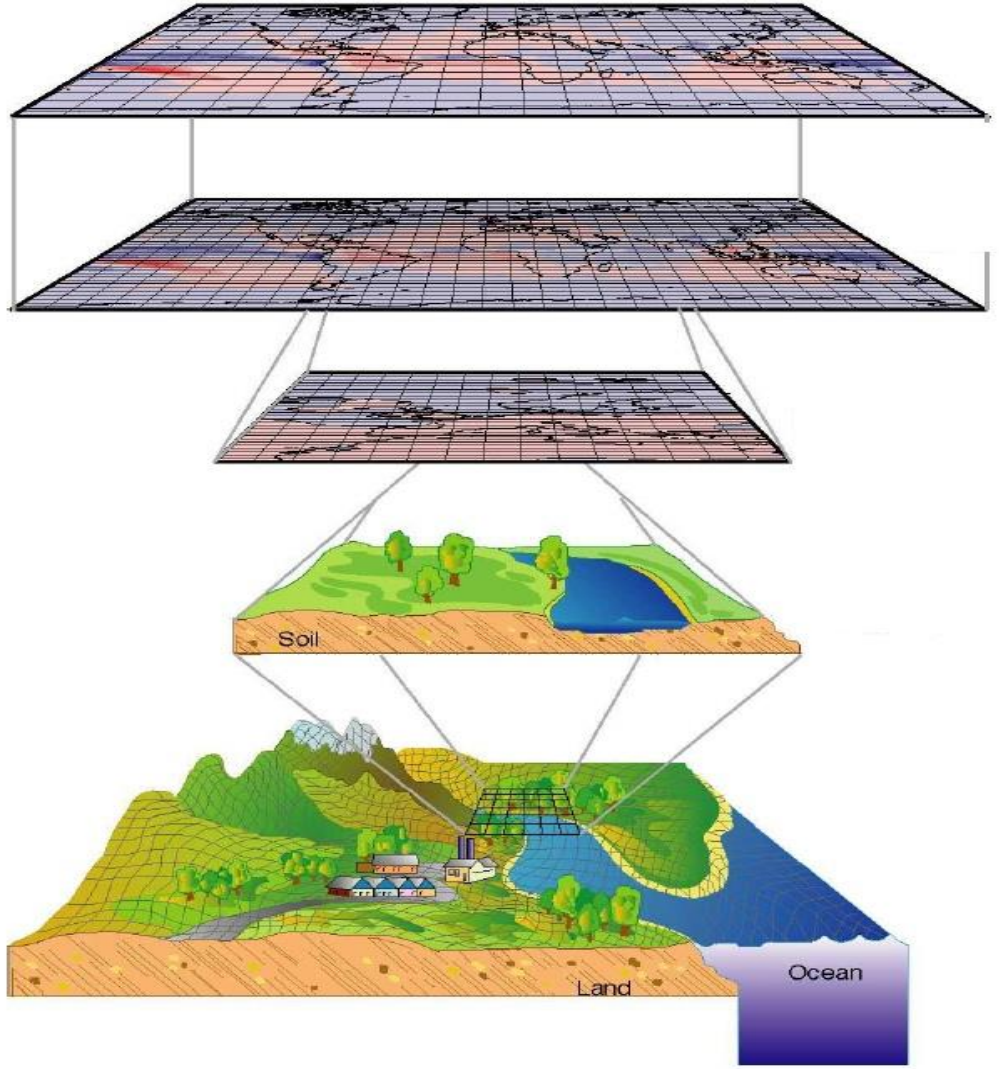




Schematic of Climate Models

Climate models are systems of differential equations based on the basic laws of physics

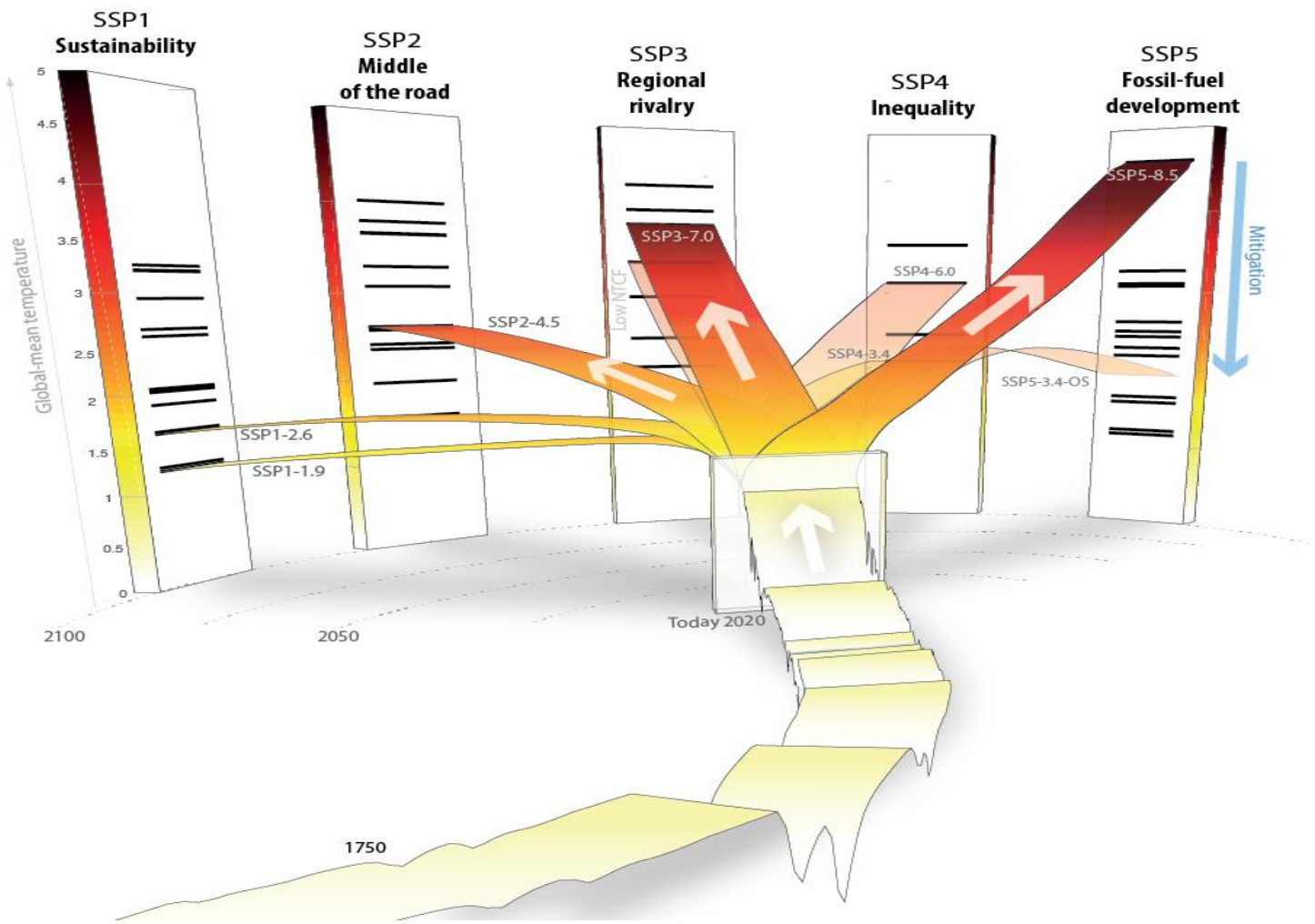
They characterize how energy and matter interact to drive the different components of the Earth's climate system



Downscaling

II/ Climate Modeling

- Forcing scenarios



- The five socio-economic SSP families
- SSP scenarios
- Branches of the respective scenarios along the different socio-economic SSP families

II/ Climate Modeling

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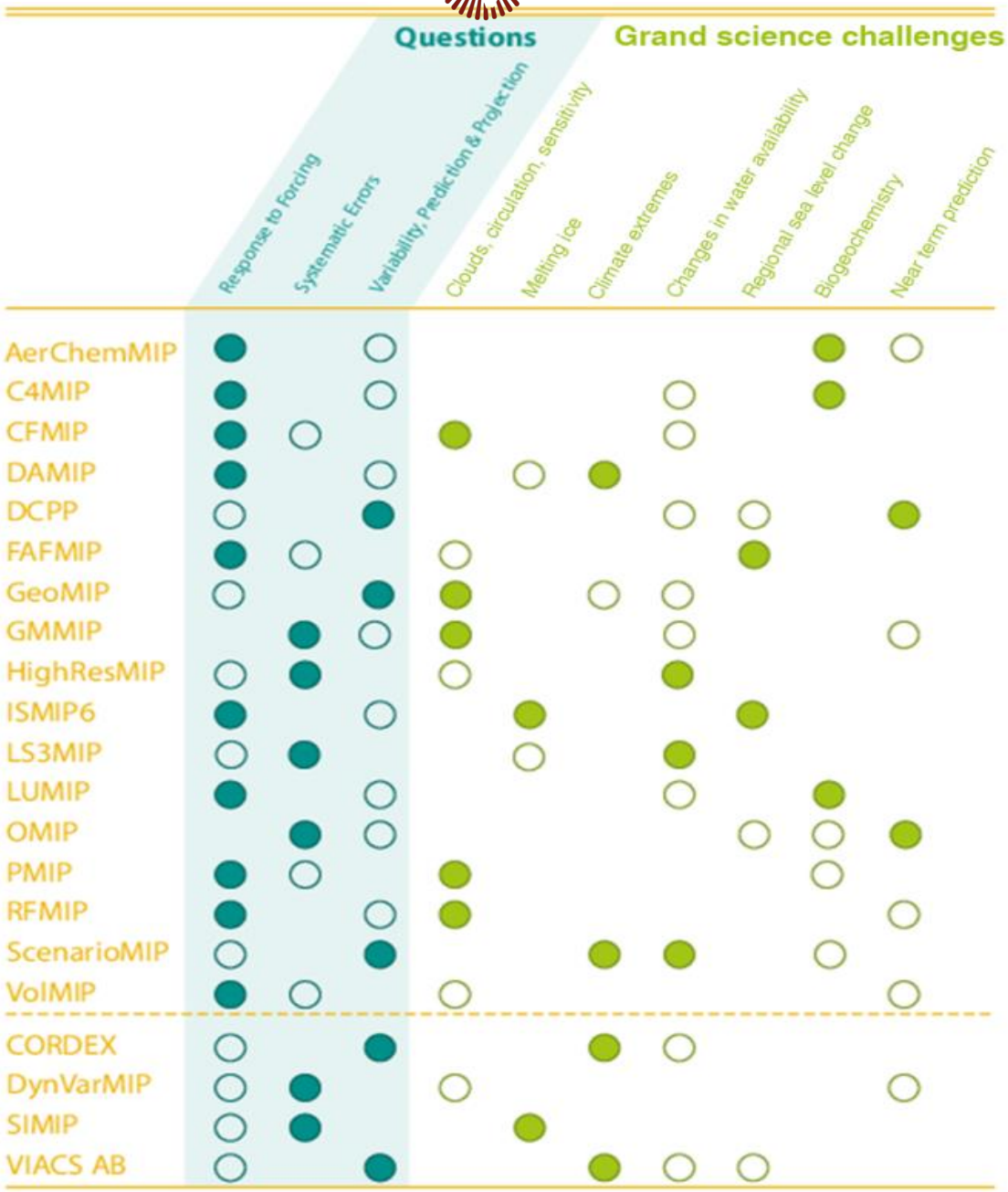
- CMIP6: GCMs and ESMs
  - For climate change studies: Historical, ScenarioMIP, HighResMIP
  - More than 30 GCMs/ESMs have made available daily data
  - SSP1-2.6; SSP2-4.5; SSP5-8.5
- CORDEX: RCMs
  - For climate change studies: Evaluation, Historical and Projections – Downscaling CMIP5
  - More than 20 RCMs experiments available
  - RCP4.5, RCP8.5
- CORDEX2: Downscaling CMIP6 – about to start



III/ Simulations of Extremes

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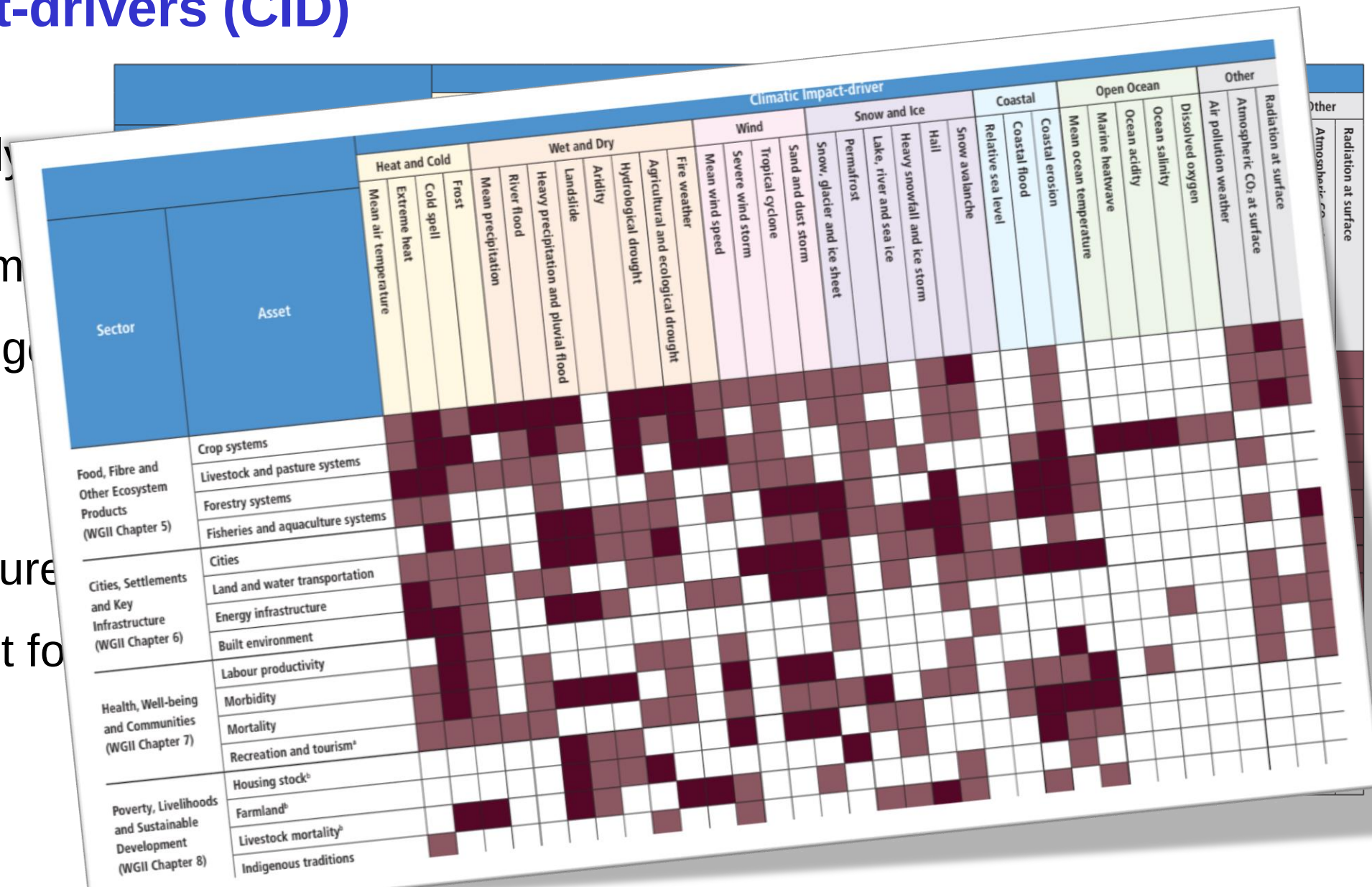
➢ Climatic Impact-drivers (CID)

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



III/ Simulations of Extremes

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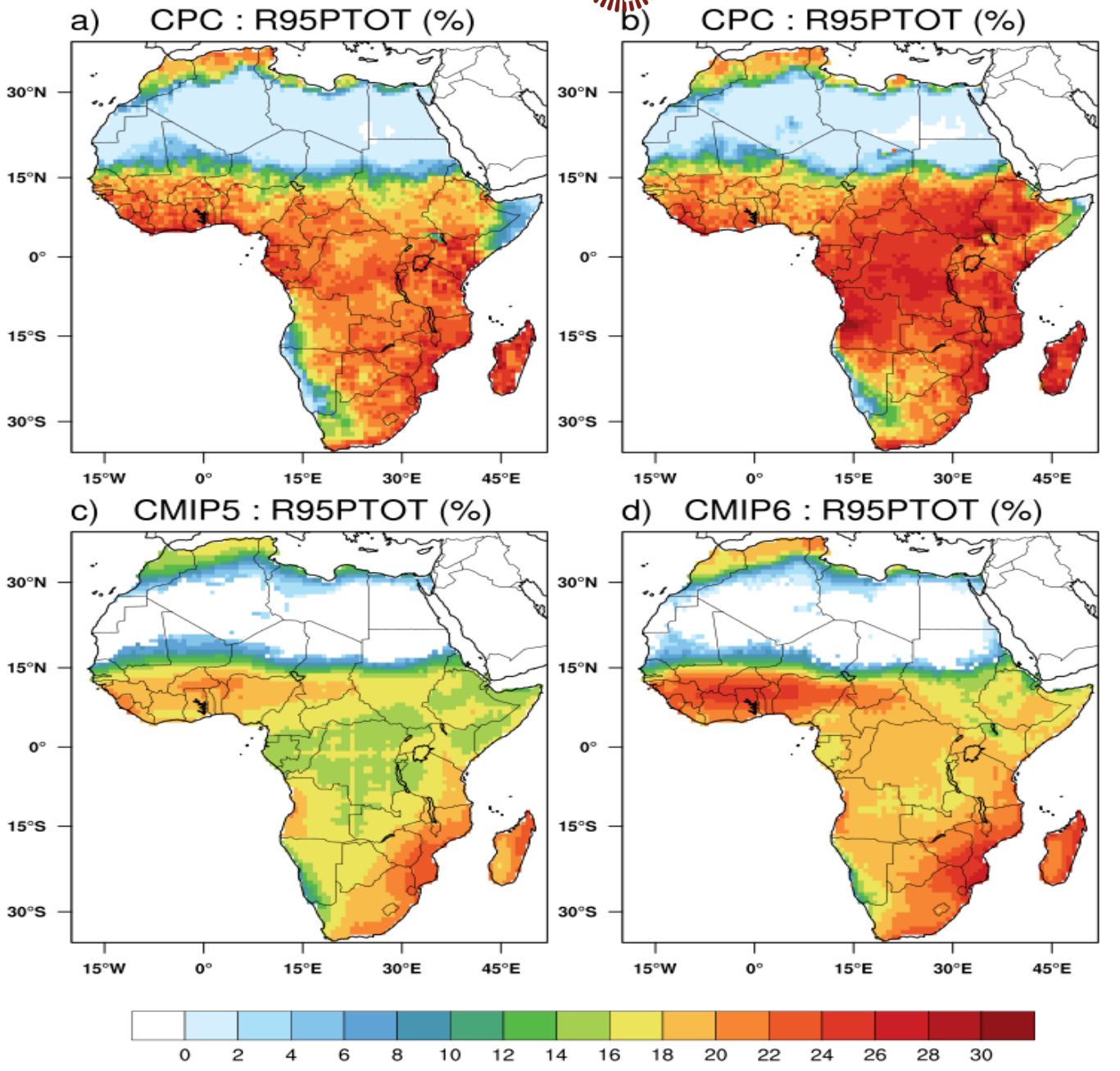
❑ Extreme precipitations

- Biased simulations in Africa
- Uncertain changes in many areas
- CMIP6 sees some improvements



III/ Simulations of Extremes

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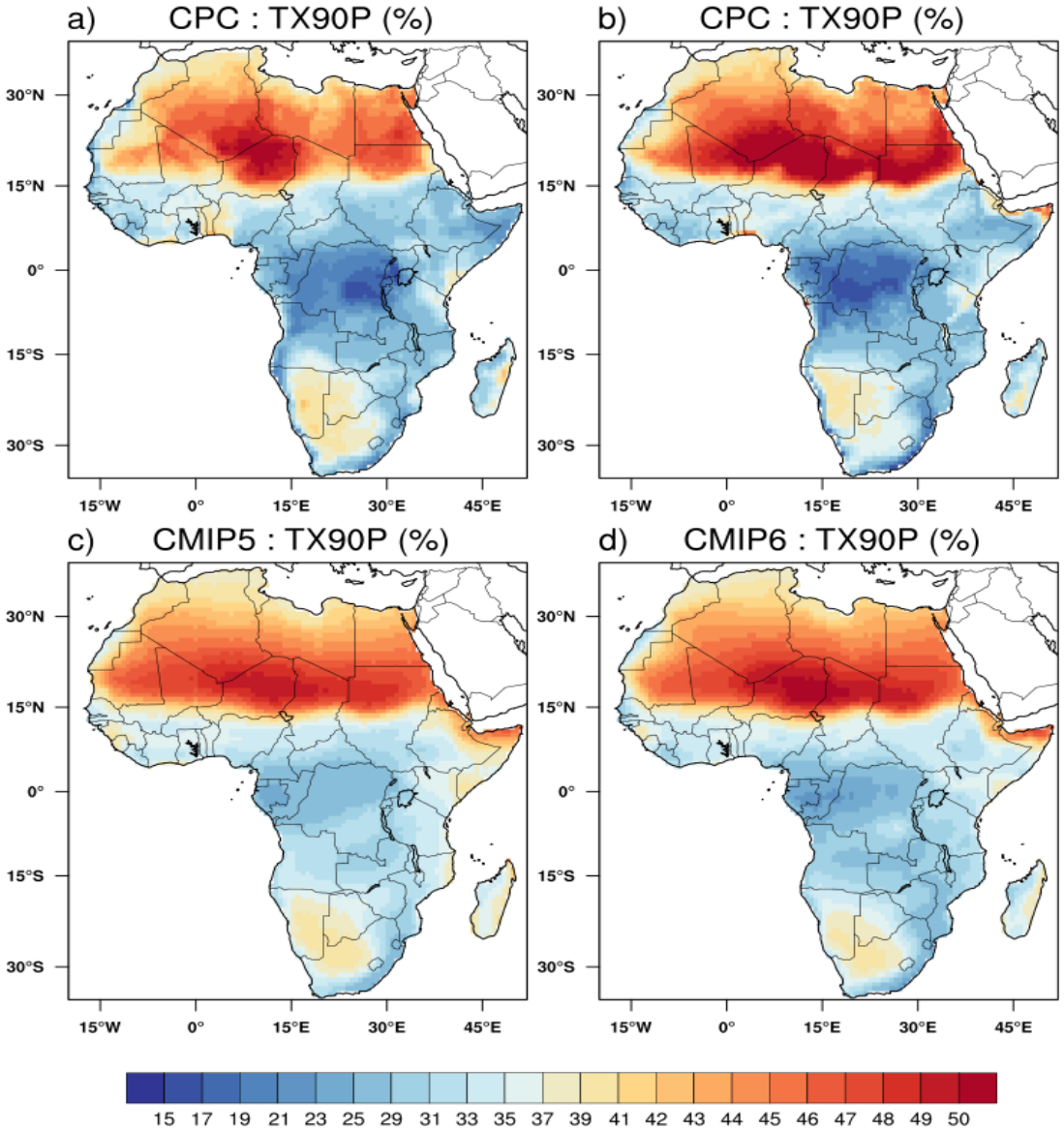
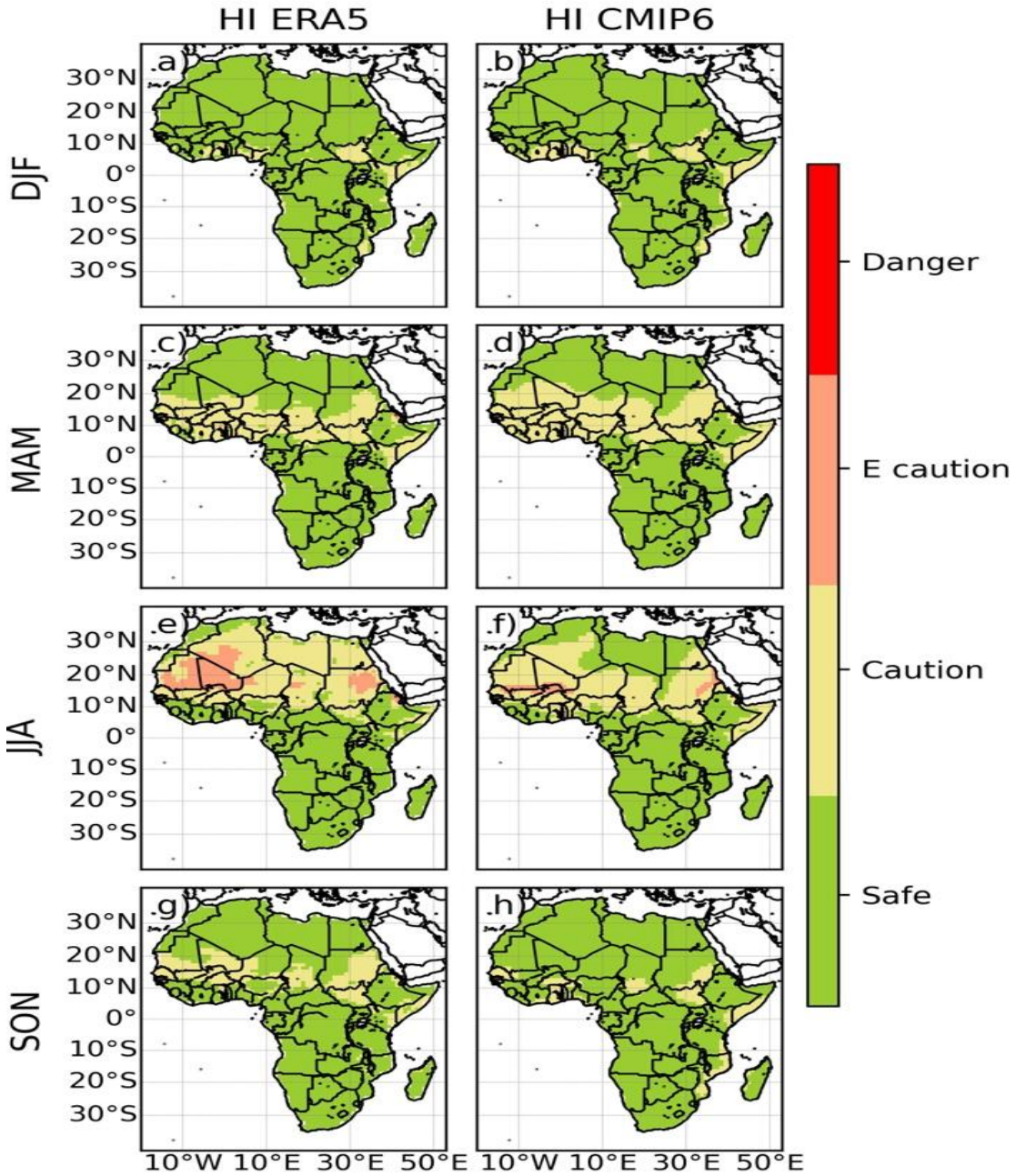
❑ Extreme heat





III/ Simulations of Extremes

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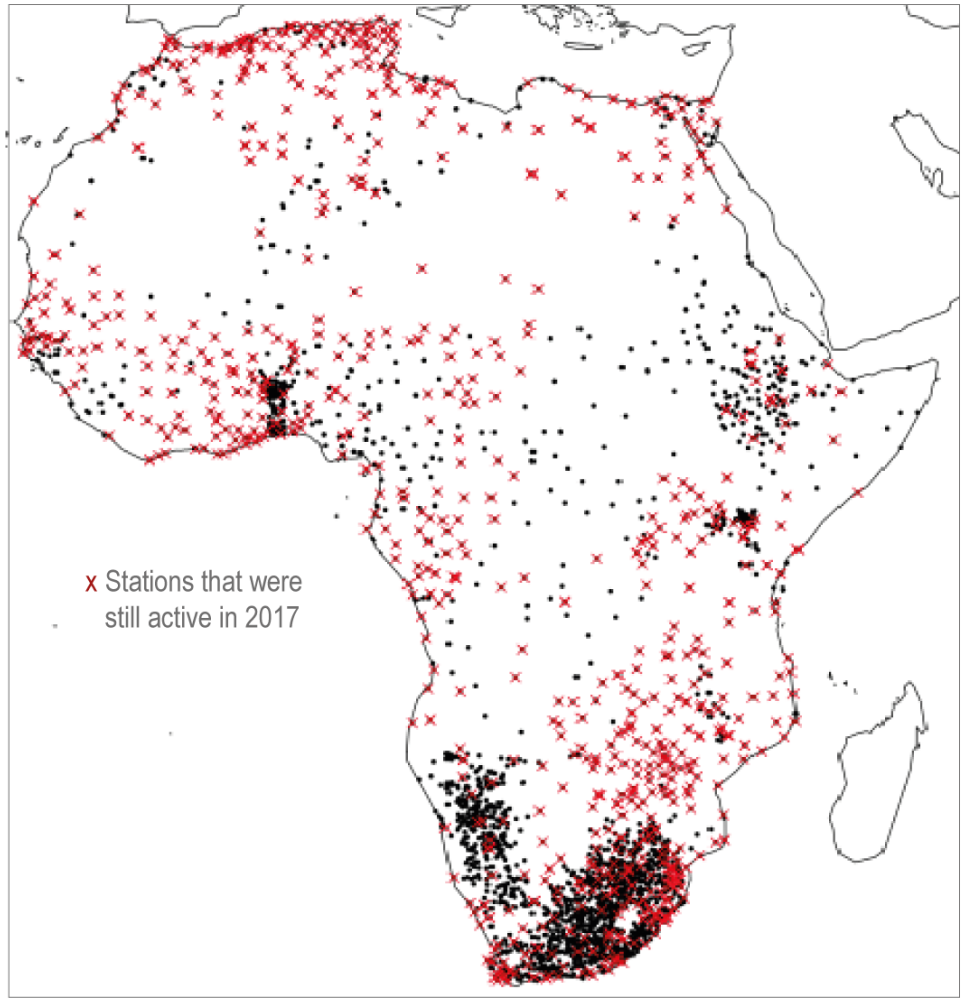
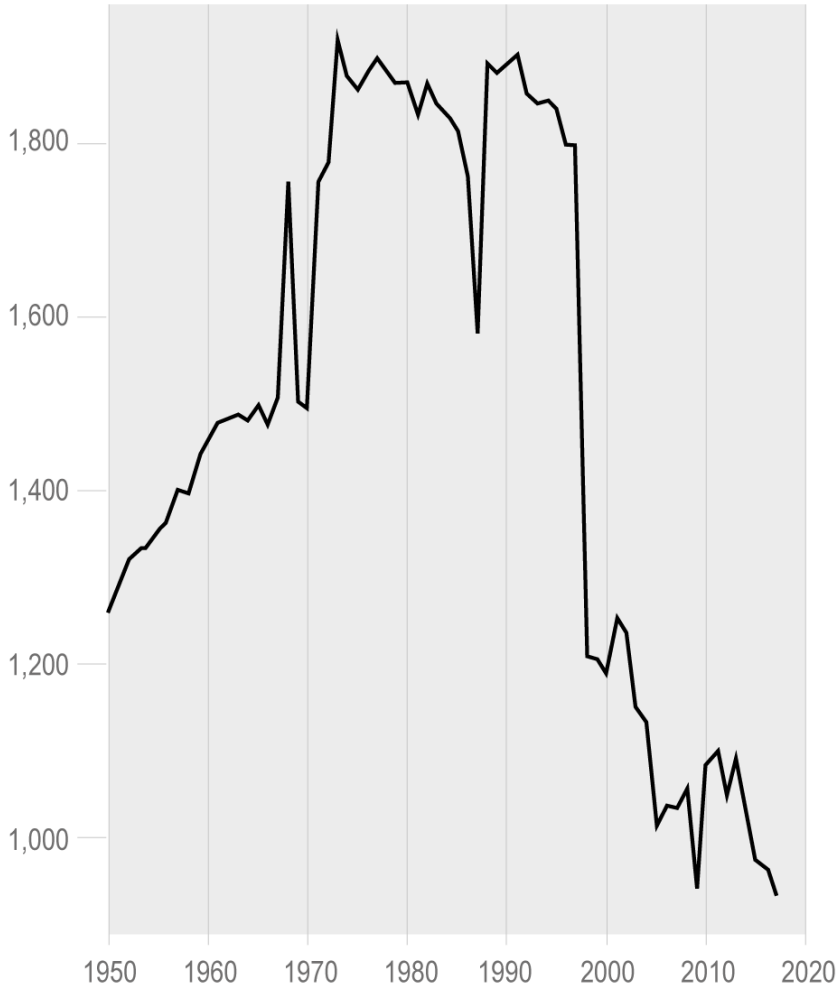
❑ Data and validation issues

- Large regions in Africa lack good quality data

(a) Distribution of weather stations since 1950



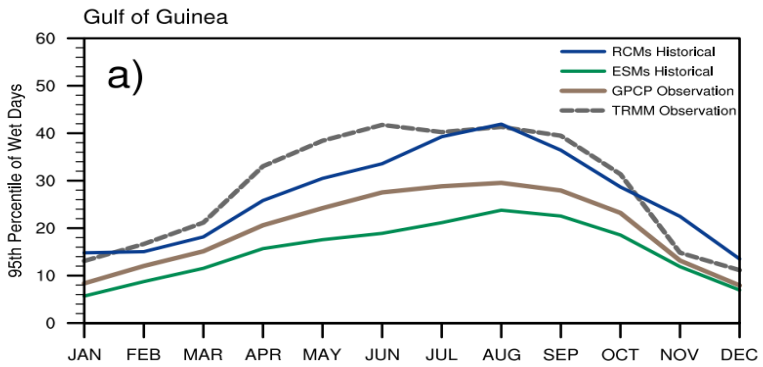
(b) Number of weather stations since 1950

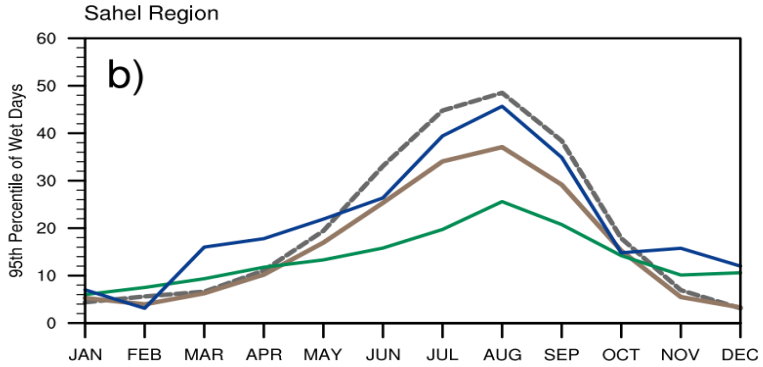


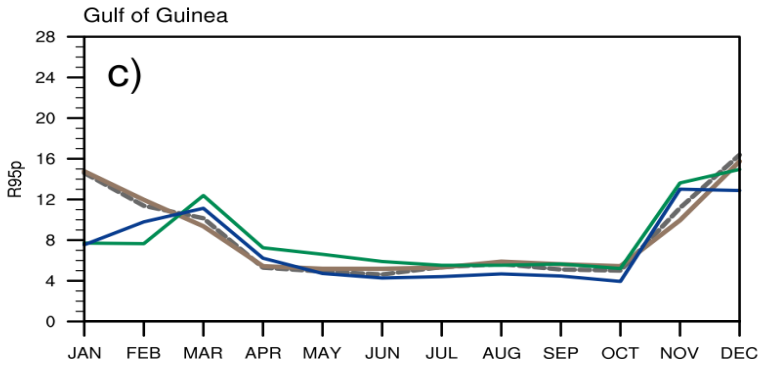
IPCC 2022, WG2

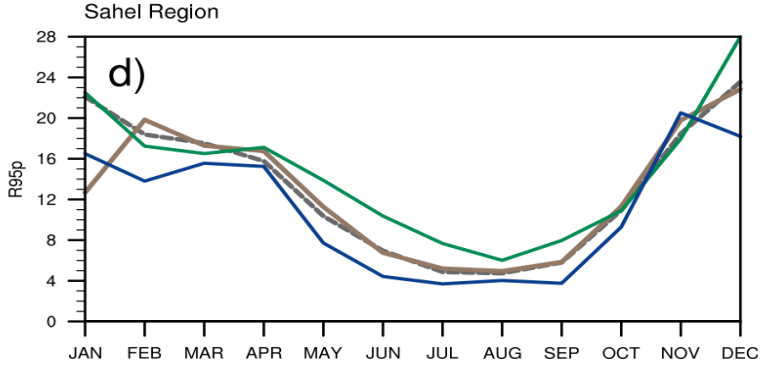
III/ Simulations of Extremes

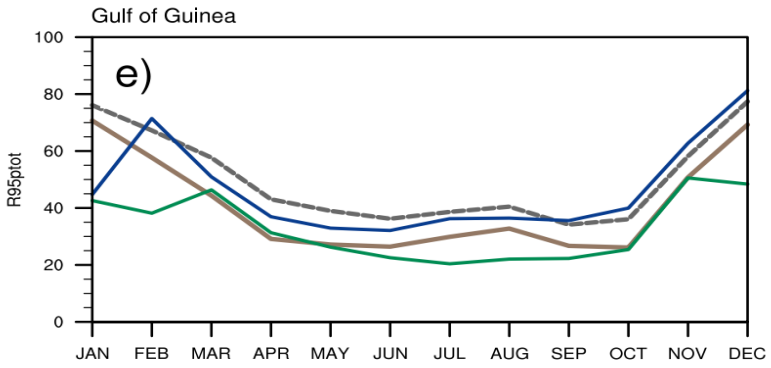
❑ Data and validation issues

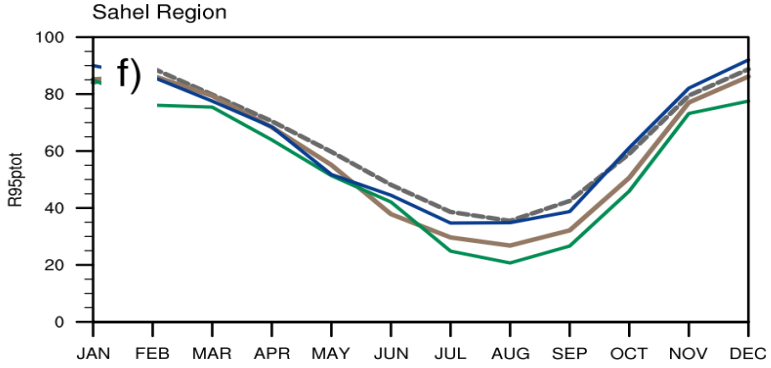










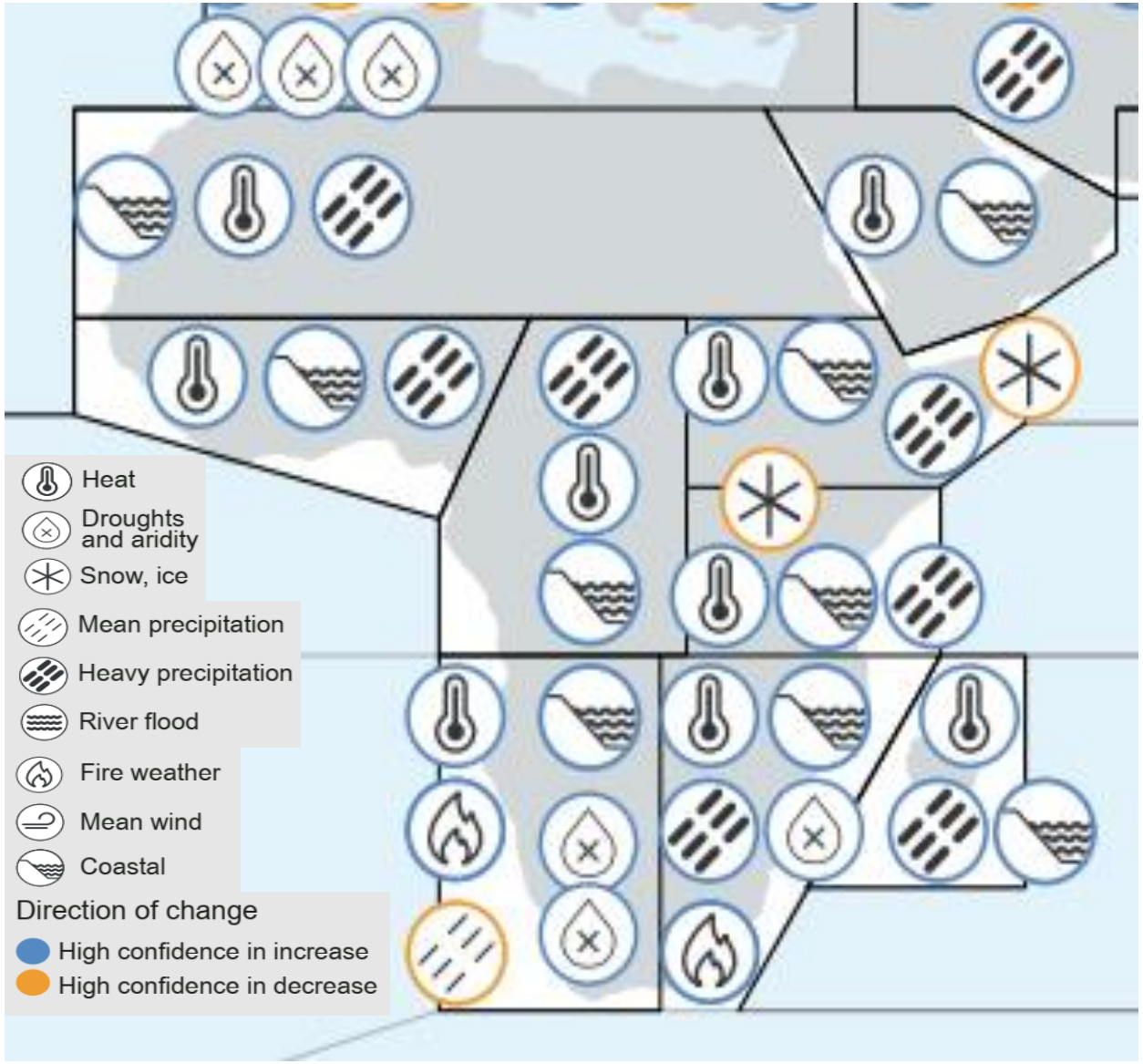


- LR simulations follow LR products
- HR simulations follow HR products

III/ Future climate extremes

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 show up
- Eastern Africa: Decreased Snow/Ice coverage emerges



IPCC WG1, 2021

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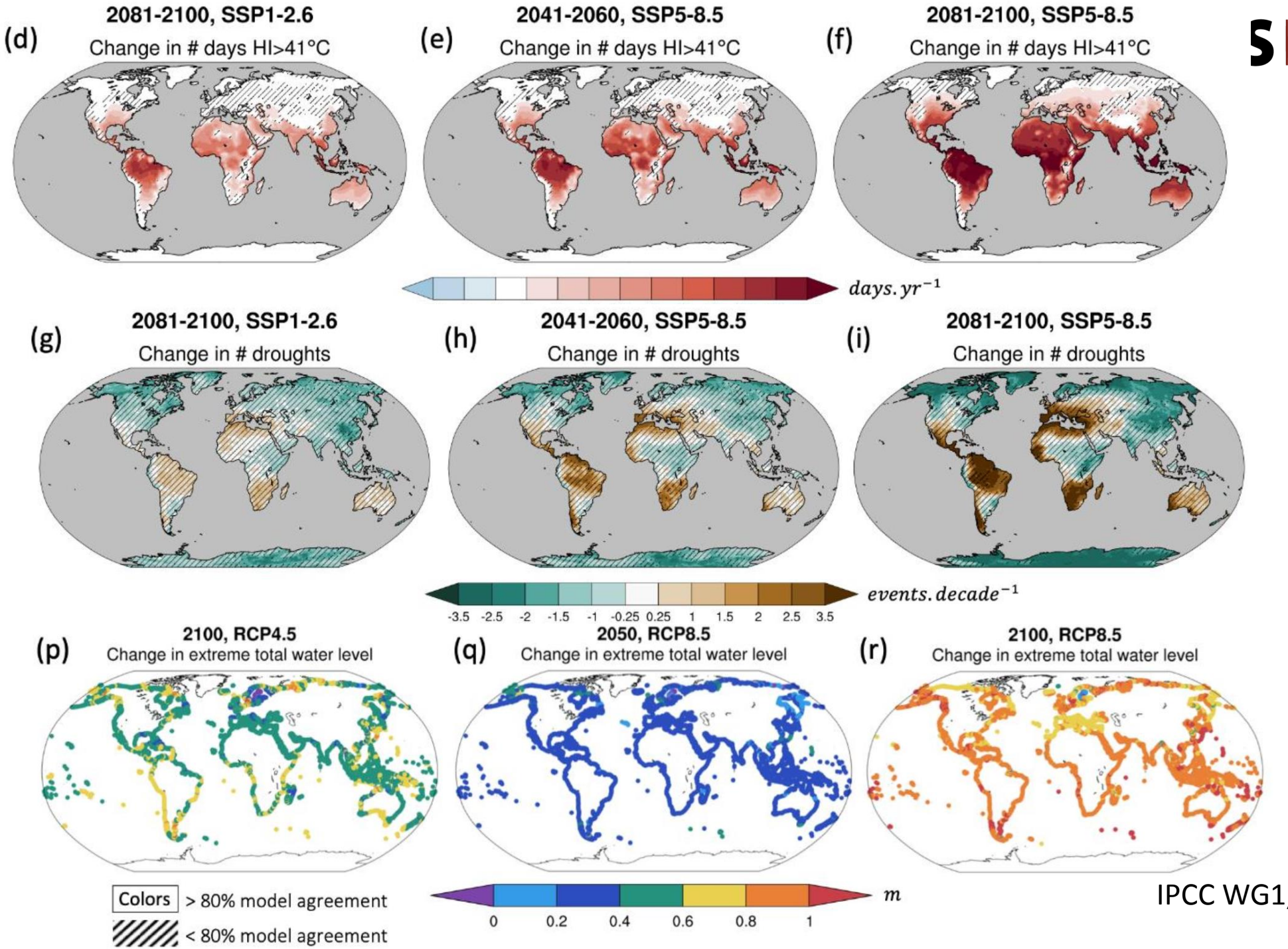

IPCC WG1, 2021

IV/ Opportunity brought by AI

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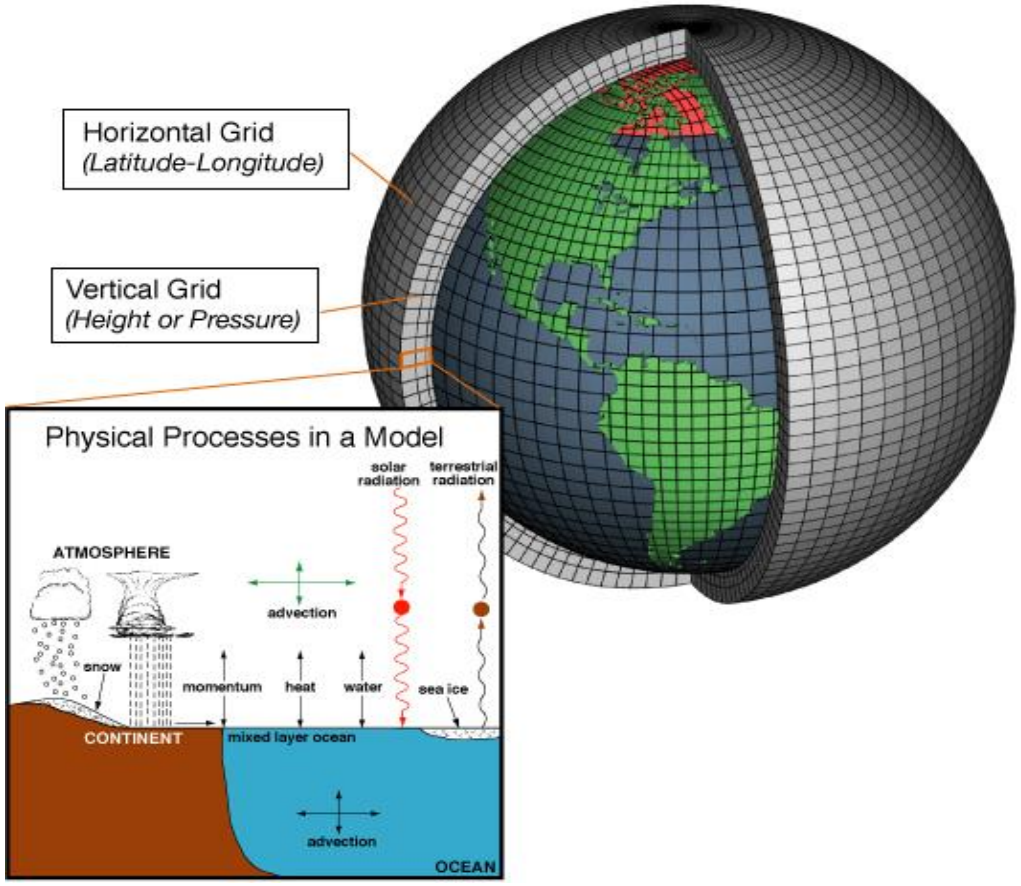
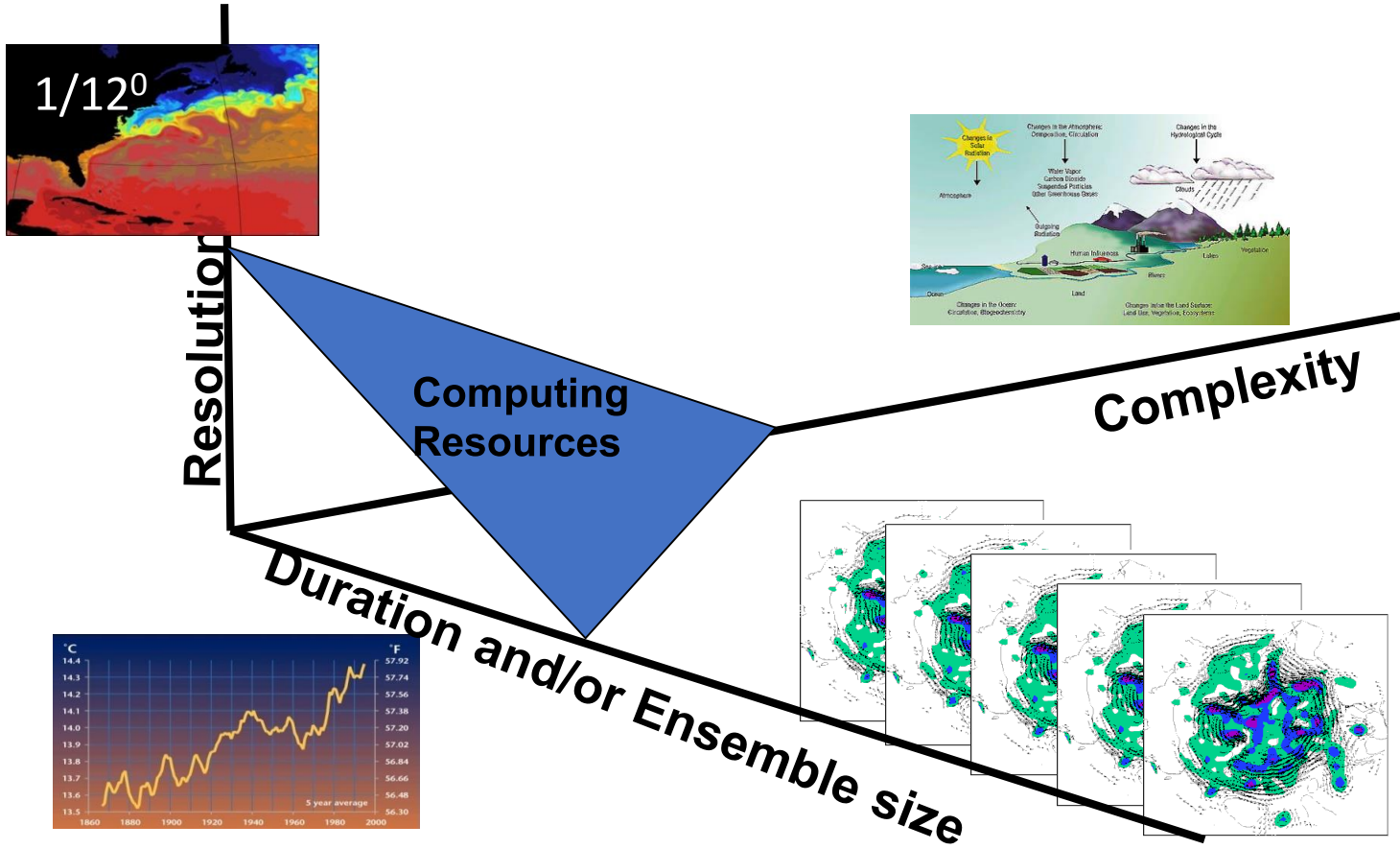
❑ Observational data and climate modeling

Schematic of climate models



Improving climate models



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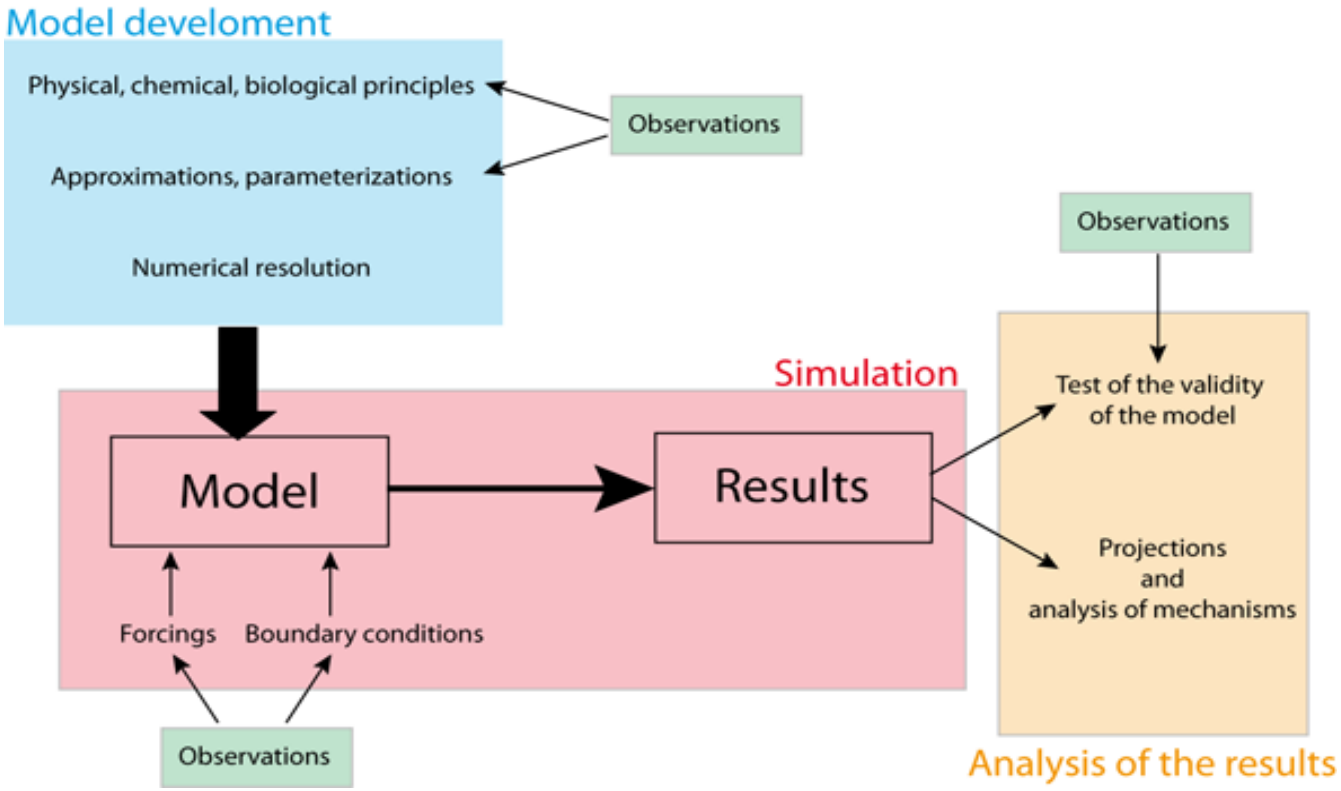
❑ Observational data and climate modeling

Workflow



The potential of machine learning application learning lies everywhere in the workflow

- Climate data monitoring, quality control, data fusion from different sources
- Emulate model components, develop improved parametrization schemes, learn the underlying equations of motion
- Better-suite boundary forcings, physical consistency
- Bias correction, feature detection, multimodel ensembling, uncertainty quantification, further downscaling

V/ Summary and Conclusion

- Climate Models are well advanced to provide “reliable” climate change projections under greenhouse gas forcings (i.e. future Worlds)
- Some bias exist in the observed climate extremes
- Some bias exist in the simulated climate extremes
- The projections should be tailored and relevant sectorial indices (i.e. CID) developed
- Droughts, Floods, Heatwaves, Sea level rise will drastically increase in WA --> Disasters
- EW4A --- > climate information in a climate service framework -- DRR
- Bring AI into play to improve the information

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